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Section A.—PHYSICS.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

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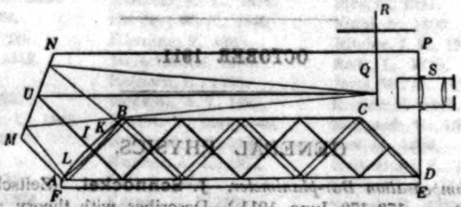
GENERAL PHYSICS.

1303. *Compensation Bar-planimeter.* **J. Schnöckel.** (Zeitschr. Instrumentenk. 31. pp. 173–179, June, 1911.)—Describes, with theory, a new type of compensation planimeter, whose action is based on that of the Prytz hatchet planimeter. Unlike the Prytz instrument, the bar carries a roller or a ball which can travel along the bar, its axis being perpendicular to the vertical plane containing the bar, so that the distance of the tracing-point from the wheel does not remain constant, as is the case with the distance from tracing-point to knife-edge in the Prytz planimeter. The end of the bar opposite to that carrying the tracing-point has a pointer which is directed towards some observed mark on a scale (provided with the instrument) at the beginning of an observation. The scale has a notch in one end fitting to a needle-point stuck in the tracing-table, so that it can be moved out of the way while the tracing-point is taken round the figure whose area is to be measured. Afterwards the scale is brought back to the pointer, and 10 times the observed difference between the initial and final scale-readings gives once or twice the area of the traced figure according to the position of the roller with reference to two marks on the bar. For details of corrections the tables in the original paper should be referred to. [See also Abstract No. 591 (1911).] A. W.

1304. *Durand-Amsler Radial Planimeter.* **A. Amsler, E. Hammer.** (Zeitschr. Instrumentenk. 31. pp. 213–214 and 214–217, July, 1911.)—The planimeter has a central weight A, which is placed centrally on the circular diagram recording in polar co-ordinates air pressure, temperature, &c., whose mean value is to be determined. The weight A has two parallel sliding rods through it, and these carry a frame to which are fastened the tracing-point and the roller with attached graduated discs. The line from the tracing-point to the centre of the weight A is the radius vector at each instant. The axis of the roller is parallel to this line. When the tracing-point is taken round the polar curve, the reading of the roller is proportional to the mean radius vector and to the angle through which the radius vector has turned. Hence the mean polar ordinate can be easily obtained by division. The second part of the paper deals with tests of the instrument and comparison with the polar planimeter. A. W.

1305. *New Mercury Level.* **F. Biske.** (Zeitschr. Instrumentenk. 31. pp. 209–213, July, 1911.)—Describes a new type of mercury level in which use is made of the principle of auto-collimation. The box ABCDEF is provided with a collimator objective AB of diam. 4 cm. inclined at 45° to AD, which is 16·97 cm. long, BC being consequently 11·82 cm. long and 2·82 cm. from the reflecting surface of the mercury ADEF. BC, CD, and MN are mirrors. The cross-wires at Q are movable by means of the micrometer screw R, and are illuminated by means of a 4-volt metal filament lamp. With the cross-wires in the zero position and FE horizontal, an image of the cross-wires, formed by the rays returning after multiple reflection from the surfaces of the mercury and the mirrors, is seen coincident with the cross-wires, through the eyepiece S. Any alteration of the inclination of FE causes a deviation of the image, and from a knowledge of the amount of this deviation and the number of reflections from the mirror BC and from the mercury surface, the angle through which FE has moved can easily be calculated. Since the mark which gives the level is a luminous image, the instrument can be adapted to register photographically continuous variations of level, as in slight earth-vibrations. A. W.



1306. *Approximate Harmonic Analysis by selected Ordinates.* **S. P. Thompson.** (Phys. Soc., Proc. 23. pp. 334–342; Discussion, p. 343, Aug., 1911.)—Assume with Fourier that if y be a single-valued periodic function of x then $y = \Sigma A_n \sin nx + \Sigma B_n \cos nx$. Then to find the coefficient of any term, A_n or B_n, it suffices to measure off, on the curve, $2n$ equidistant ordinates over one period, that is, spaced at successive intervals apart of π/n. Then, having reversed the sign of every alternate ordinate, the simple algebraic mean of them gives the coefficient sought. For cosine coefficients the first ordinate must be taken at the origin, while for sine coefficients the first ordinate must be taken at a point $\pi/2n$ from the origin. In symbols we have—

$$A_n = (1/2n)\,[y_{\pi/2n} - y_{3\pi/2n} + y_{5\pi/2n} - \ldots]$$

and—

$$B_n = (1/2n)\,[y_0 - y_{\pi/n} + y_{2\pi/n} - \ldots].$$

In applying this method the only limitation is that if the 3 nth, or the 5 nth &c., be present these will be included in the average found by the process and must, if present, be separately determined and eliminated. The process is much facilitated by the use of templates of transparent celluloid having equi-spaced vertical lines engraved upon them. They are laid down on the curve, and the values of the selected ordinates are thus readily measured off. For analysis of valve-motions, of alternating-current curves, of tidal observations and diurnal magnetic variations, the method presents certain advantages, as it requires no multiplication of ordinates by sines or cosines. In the *discussion*, **A. Russell** said that the method can be usefully employed in interpolation as well as in harmonic analysis. **G. H. Darwin** pointed out that in some preceding methods some of the author's formulæ are employed.

A. R.

1307. *Compression of Liquids at High Pressures.* **C. A. Parsons** and **S. S. Cook.** (Roy. Soc., Proc. Ser. A. 85. pp. 332–348, July 5, 1911.)—The apparatus consisted of a steel mould of about 4 in. bore and 12 in. external diam., placed under a heavy hydraulic press capable of exerting a pressure of 2000 tons, with a main ram of 29 in. diameter and a 6-in. lifting ram. The mould was constructed of gun-steel, having an elastic limit of about 40 tons per sq. in. The pressure on the ram was recorded by a carefully calibrated Bourdon gauge, and the depression of the liquid in the mould measured by a pair of multiplying calipers, inserted between the top of the mould and a projecting collar on the plunger. Various corrections to the observed readings were made, and the results tabulated and graphed. Expressing compressibility in atmospheric units, *i.e.*, as the ratio of the decrease of volume per atmo. of pressure to the volume of the liquid, the following values were deduced for the isothermal coefficients of compressibility of water, ether, and paraffin oil :—

Substance.	Temperature.	Pressure.	Compressibility.
Water	4° C.	Atmospheric	50×10^{6}
		2000 atmos.	25 × „
		4500 „	22·5 × „
Ether	85° C.	Atmospheric	165 × „
		1000 atmos.	64 × „
		2000 „	42·5 × „
		4500 „	18 × „
Paraffin Oil.......	84° C.	Atmospheric	87 × „
		2000 atmos.	34 × „
		4500 „	17 × „

The average values of the molecular force deduced from the heat lost during adiabatic expansion are as follows :—

	Molecular Forces.
Water (for pressures between 0 and 4550 atmos.)..................	2150 atmos.
Ether „ „ 0 and 4000 „	2440 „
Paraffin Oil „ „ 0 and 4600 „	2920 „

A. W.

1308. *Simple Graphical Method for the Harmonic Analysis of a Cyclic Function.* **J. R. Ashworth.** (Electrician, 67. p. 888, Sept. 15, 1911.)—The author simplifies J. Harrison's graphical method of finding the harmonics of a given periodic curve. The period of the given curve is divided into *n* equal parts, and ordinates $y_1, y_2 \ldots y_n$ are erected. These ordinates are treated as coplanar forces radiating from a common centre at angles θ, 2θ, 3θ, &c., measured from the horizontal axis in the positive direction, and then their resultant is found by the polygon of forces. This resultant is $n/2$ times the magnitude of the amplitude A of the first term of the analysis, and the angle ϕ_1 is given by $\tan \phi_1 = \cot \alpha$, where α is the angle which the resultant makes with the positive part of the horizontal axis. The constants of the second harmonic are then found in the same way, the vectors now being placed at angles 2θ, 4θ, $6\theta \ldots$ and so on. The author shows that the practice of the method can be greatly accelerated by using a special transparent protractor. When the higher harmonics are unimportant or are not required this method of analysis will be found useful. A. R.

1309. *Elasticity Modulus and Dilatation of Metals.* **H. Sieglerschmidt.** (Ann. d. Physik, 35. 4. pp. 775–782, July 25, 1911.)—[See Abstracts Nos. 1616, 1618 (1910).] The author has previously obtained the equation $\mathrm{E}\beta/1000\mathrm{S}w) \sqrt[3]{(\mathrm{A})} = 100$, where β = temperature coefficient of expansion, E = modulus of elasticity, w = specific heat, S = specific gravity, A = atomic weight. But since the quantity on the left shows as much as 20 per cent. variation above and below the empirical value of 100, the present paper is devoted to obtaining a more accurate relation. The values of E, β, w/β, A, $1/\mathrm{A}\beta$, and S, are known authoritatively and are tabulated. Hence a curve is plotted connecting E/S and $1/\mathrm{A}\beta$, which obeys accurately a law of the form $\mathrm{E/S} = \mathrm{C}(1/\mathrm{A}\beta)^n$, C and n being constants. By plotting values of log (E/S) against log $(1/\mathrm{A}\beta)$ it is found that $\mathrm{C} = 34{,}000$, $n = 1{\cdot}2$; these values give for most metals not more than 4 per cent. variation. According to Dulong's law $\mathrm{A}w = \sim 6{\cdot}4$ for all elements, hence from the above equation $\mathrm{E/S} = \mathrm{C}_1(w/\beta)n_1$; by plotting E/S and w/β, C_1 is found to be $= 1390$ and $n_1 = 4/3$. This relation, however, is not obeyed so closely as the previous one. Now E/S is a measure of the mechanical work done during elastic strain; w/β measures work done during strain due to change of temperature, so that both sides of the equation are of the same dimensions. A table of calculated results shows that each of the new equations deduced is a more accurate interpretation than that of the previous paper, but the equation $\mathrm{E/S} = \mathrm{C}(1/\mathrm{A}\beta)^n$ is the most accurate. The author concludes that relations of the elastic and thermal constants of the elementary metals are best represented by the general equation $\mathrm{E/S} = \text{function } 1/\mathrm{A}\beta = \mathrm{C}(1/\mathrm{A}\beta)^n$. The values of C and n given are only empirical and require, for their confirmation, accurate determinations of E, β, w and S under similar conditions. C. A. M. S.

1310. *Dissipation of Energy in Torsionally Oscillating Wires; Effects produced by Change of Temperature.* **J. B. Ritchie.** (Roy. Soc. Edinburgh, Proc. 31. pp. 424–439, 1910–1911.)—Deals with the effect of temperature on the constants of the equation $y^n (x + a) = b$, which represents the law of decrease of torsional oscillations of an iron wire. Wires of nine different metals were tested: brass, Cu, Al, Sn, Zn, Ag, German silver, Pt, and Ni. Of these brass, Sn, Zn, Ag, German silver and Ni, were found at the ordinary temperature to give close agreement, over a very large range of oscillations, to the general law. With the remaining metals no one value of a could be fixed.

C. A. M. S.

1811. *Apparatus for inducing Fatigue in Wires by repeated Extensional and Rotational Strains.* **J. B. Ritchie.** (Roy. Soc. Edinburgh, Proc. 31. pp. 440–447, 1910–1911.)—Shows the effect produced by a repeated application of an extensional force and by the repeated application of a twist to one end of a wire, the other end being held firm. The apparatus consists essentially of a pendulum which, when oscillating, is kept in a uniform range of oscillation by electrical arrangements. Results are given for a brass wire. In general there seems little effect produced on the constants of the equation [see preceding Abstract] by fatigue, although some of them varied appreciably. C. A. M. S.

1812. *Occasional Low Elastic Limit in I-beams; the Practical Meaning of Elastic Limit.* **E. L. Hancock.** (Eng. News, 66. pp. 180–181, Aug. 10, 1911. Abstract of paper read before the Amer. Soc. for Testing Materials, 1911.)—Reviews discussion on tests by E. Marburg on I-beams of different sizes, which seemed to show that the metal at conjunction of flange and root in some instances had a surprisingly low elastic limit. Strips from the root showed a bend in stress-strain line at values as low as 10,000 to 18,000 lbs. per sq. in. The impression conveyed was that deficient rolling pressure caused this. In 1910 E. L. Hancock reported some tests to the American Society for Testing Materials. They did not reveal any marked cases of low elastic limit, but some values were below those expected. Recent work of Hancock [see Abstract No. 1074 (1911)] is discussed. The author protests against the tendency to use "elastic limit" instead of "yield-point." More experimental work is advocated, but the opinion expressed is that "steel whose ultimate strength, ductility and yield-point are good should be accepted with fair confidence irrespective of delicate determinations of 'elastic limit,' at least until plausible reasons to the contrary are brought to light." C. A. M. S.

1813. *Contraction in Area of Iron for Large Extensions.* **R. Plank.** (Zeitschr. Vereines Deutsch. Ing. 55. pp. 1479–1488, Sept. 2, 1911.)—A mathematical investigation is made of the theory of the lateral contraction of a specimen placed in tension, and the results are given of tests which confirm the theory. Since the longitudinal strain is never less than the lateral strain, a decrease of volume during a test to destruction is impossible; the limiting case is when the volume remains constant. An equation is deduced whereby the limiting volume m_0, of m, the ratio of longitudinal to lateral strain, may be calculated; for small strains it is $=2$. The specimens were turned with extreme care, so that they bore a spiral mark of fine pitch. By microscopic measurements of the dimensions and pitch of these rings, the over-all and local changes of the test-piece were known very accurately. The originally circular cross-section became elliptical and the eccentricities were recorded. From the recorded data are calculated the longitudinal, lateral, and volume strains, and the values of m. It is seen that m at first decreases very rapidly as the strain increases; the rate of decrease falls off as the local contraction commences previous to fracture; at about 20 per cent. elongation, m approaches closely to the limiting value, m_0, for zero volume-change and thenceforth follows closely the values of m_0 for the corresponding strains. The conclusion follows that the elaborate measurement of local strains all along the bar may be replaced by the much easier measurement of the diams. at several points of the stricture, since the volume at stricture remains constant. The specimens tested were 10 mm. in diam. and the markings had an initial pitch of 0·248 mm.; they were tested by the impact of a 25-kg. bar falling 0·5 m. C. A. M. S.

1314. *The Lüders' Lines on Mild Steel.* **W. Mason.** (Phys. Soc., Proc. 23. pp. 305–330; Discussion, pp. 330–333, Aug., 1911.)—Previous investigations have shown that Lüders' lines on specimens of mild steel and wrought iron, strained in tension, are inclined at about 50 deg. to the axis of pull. For tests in compression the angle of the lines is commonly supposed to be about 40 deg., but some doubt has been thrown on this point. The author had found previously that the lines were well developed on the surface of mild steel tubes. The experiments were conducted on tubular specimens, as it was easy to obtain a compressive stress of practically uniform distribution under end pressure, while at the same time a hoop tensile stress could be induced by internal fluid pressure. Mild steel tubes, either hot or cold drawn, and mostly annealed, were used. They varied in bore from 2½ to 3 in., and in thickness of wall from 0·08 to 0·125 in. The Lüders' lines on the outer surface appeared at the yield-point. In all cases where there were lines on the inner and outer surfaces of a tube, an inner and an outer line and also the ends of these lines were found to be radially opposite, showing that the lines were traces of surfaces of disturbance which passed through the tube wall, and indicating that the disturbance spread spirally onwards and not outwardly from a line initially formed on the more severely stressed inner surface. The inclination of the lines to the axis of the tube was found to vary in the following way for tubes under end load and internal pressure:—

$$\text{For } \frac{\text{longitudinal stress}}{\text{hoop stress}} = 0{\cdot}25,\ \alpha = 42 \text{ deg. (approx.)}$$

$$\text{For } \frac{\text{longitudinal stress}}{\text{hoop stress}} = 1{\cdot}0,\ \alpha = 45 \text{ deg.}\quad ,,$$

$$\text{For longitudinal stress only}\quad \alpha = 50 \text{ deg.}\quad ,,$$

For values between 0·25 and 1, and between 1 and ∞, α becomes progressively larger. The conclusion is drawn that the Lüders' surfaces have the same, or approximately the same, inclination to an axis of simple pull or simple push. With stresses of opposite sign at right angles to each other, the lines and surfaces are more inclined to the stress of greater intensity, and with equal intensities the surfaces are at about 45 deg. The author suggests that if a shear stress of given intensity be the only condition for that spreading of plastic strain which commences at the yield-point, then there is no reason why there should be any variation in the angle of the Lüders' lines and surfaces. The variation suggests that not only the max. shear stress but also the magnitudes of the principal stresses are factors in producing the yielding condition in mild steel. [See also Abstract No. 798B (1904).]

C. O. B.

1315. *Strength of Steels in Compound Stress, and Endurance under Repetition of Stress.* **L. B. Turner.** (Engineering, 92. pp. 115–117, July 28; 183–185, Aug. 11; 246–250, Aug. 25, and pp. 305–307, Sept. 8, 1911.)—The author gives the results of (1) some further tests with static pull and torque; (2) experiments in three-dimensional stress; (3) an investigation of endurance of various steels under alternations of tension and shear. He shows that for mild steel the shear theory holds good, and states that "in all the materials the elastic limit and the yield-point in the testing machine coincided." Further, "the experiments show, therefore, that the shear theory is in some materials very nearly accurate; in other materials quite appreciably inaccurate; but in all the very diverse materials tested it is greatly superior to the more generally accepted tension hypothesis." Then follows a description of experiments in three-dimensional stress. This was obtained by loading thick-walled steel tubes with a large internal fluid pressure, accompanied by more or less longitudinal pull. The same tubes were subjected to longitudinal pull alone and to torque alone. For the tests it was necessary to read diametral strains; it was rendered imperative by the quite inadequate sensitiveness of the extensometer to indicate yield-point due to internal pressure in thick tubes. An instrument was designed and named the "latometer." It is described at length. Its sensitiveness is such that it will measure the Poisson contraction of a 1-in. solid steel bar under longitudinal pull, with about the same accuracy as the Ewing extensometer measures the longitudinal stretch. This implies measurement of change of diam. to within 10^{-6} in. A simple mechanism causes a small mirror to rotate. The unsatisfactory behaviour of other instruments designed to measure lateral strain is due chiefly to the mistake of making the measuring-points carry the weight of the instrument. In the present design the latometer is free to swing about the diam. of the specimen, but is maintained in an approximately horizontal position by a link over its centre of gravity. The elastic limits in the case of three-dimensioned stress were difficult to determine, and yield-points were taken. The whole problem is complicated, and further experiments are needed. Results show that (1) the shear theory is not far from true; (2) it is sensibly untrue. The next part of the research deals with endurance under compound stress. Results on tube steels are rather unsatisfactory; mild steel results are more uniform. Tool steel showed endurance-test stress in shear equal to the elastic-limit stress, but endurance alternating tension showed much lower stress. Tests are given which show that Arnold's test [Abstract No. 1560 (1908)] does not supply the same information as is given by the Wöhler test—the limiting endurance test. The rise in temperature of the specimens was taken to check the amount of work which remains in the specimen. In one torsion specimen it was 7 deg. C. There are two appendices, (1) on frictionless pure torque apparatus, (2) on analyses, microstructures, and tensile tests of materials used. C. A. M. S.

1316. *Diffusion of Oxygen and Carbon Dioxide in Water.* **T. Carlson.** (Amer. Chem. Soc., Journ. 33. pp. 1027–1032, July, 1911.)—The coefficients of diffusion of oxygen and CO_2 in a 1 per cent. aqueous solution of KCl at 18° C. are found to be 1·720 and 1·475 per cm.^{2} per day respectively, which, corrected to 16°, become 1·607 and 1·378. The ratio between these is 1·166, which agrees well with the value 1·158 previously found by the author from determinations of the rates of solution of the gases in, and their escape from, water, and with the value 1·178 calculated by the Exner rule from the square roots of the densities of the gases. W. H. Sr.

1317. *Molecular Flow of Hydrogen through Tubes, and the Hot-wire Manometer.* **M. Knudsen.** (Ann. d. Physik, 35. 2. pp. 389–396, June 29, 1911.)—In a former paper [Abstract No. 871 (1909)] the author deduced a formula for the flow of a gas through a circular cylindrical tube, on the assumption that a gas molecule, when it hits a solid wall, is reflected in a direction which is quite independent of the direction in which it approaches the wall, and also that the molecules rebound from the wall according to the cosine law. This has now been tested, and found to be in harmony with experiments.

A. F.

1318. *Diffusion of Electrolytes in Colloids.* **L. Rolla.** (Accad. Lincei, Atti, 20. pp. 47–51, July 2, 1911.)—The author has measured, by an electrical method, the rates of diffusion of sodium and potassium chlorides in a 6 per cent. dialysed gelatine jelly, the results, calculated to 18° C., being 1·01 and 1·38 cm.^{2} per 24 hours, which agree closely with the values obtained by Öholm [Abstract No. 850 (1905)] for the diffusion of these salts in water.

W. H. St.

1319. *Mechanical Viscosity of Fluids.* **T. E. Stanton.** (Roy. Soc., Proc. Ser. A. 85. pp. 366–376, July 5, 1911.)—The experiments described were undertaken in order to investigate the relation between shearing stress and rate of distortion in fluids which are in eddying or sinuous motion—that is, motion in which the frictional resistance, at the boundaries of the solid over which they move, varies approximately as the square of the relative velocity, as distinguished from that steady or laminar motion in which the frictional resistance is proportional to the first power of the relative speed. Experiments were made with air driven through (*a*) rough and (*b*) smooth pipes. The results for the rough pipes give the following conclusions: (i) In such a pipe, through which air is moving at a speed above the critical value, it follows from the parabolic form of the curve that the mechanical viscosity is constant across the pipe up to within a relatively small distance from the boundary. (ii) Considering the variations in the shearing force on any cylindrical surface coaxial with the pipe due to variations in the velocity of flow, it is evident that, since the value of dv/dr is proportional to v_c, the velocity of the centre filament, and the shearing force varies as the square of the velocity, therefore μ, the coefficient of mechanical viscosity, is directly proportional to the velocity of flow. (iii) In two pipes in which the velocities of flow are made proportional to the respective diams., the values of dv/dr on two cylindrical surfaces, one in each pipe, whose linear dimensions are proportional to these diams. are the same. It follows, therefore, that since the respective shearing forces vary as the squares of the corresponding velocities of flow, the values of μ must, for the different pipes, be directly proportional to their diams. It appears, therefore, that the expression for the coefficient of mechanical viscosity in the artificially roughened pipes considered may be written $\mu = kv_c l$, where v_c is the velocity of flow at the axis of the pipe, l the linear dimension of the pipe, and k is a constant depending on the extent of the eddying motion. In smooth pipes it appears that the general character of the flow consists of a central region in which the ratio of the shearing stress to the rate of change of distortion is constant for any particular value of the flow, and that in the neigbourhood of the walls this alters rapidly until it becomes equal to the physical viscosity at the boundary.

A. W.

1320. *Number of Electrons in the Atom.* **H. A. Wilson.** (Phil. Mag. 21. pp. 718–722, June, 1911.)—On J. J. Thomson's theory as to electrons moving about freely inside the positive charge, it is deduced that the tubes of force from each electron occupy a volume e/ρ; that the positive sphere is divided up into volumes each containing one electron; and that each of these volumes is as nearly spherical as possible, with the electron in the middle. This will result in a symmetrical arrangement in concentric surface-layers; and the number of these layers will determine the position of an element in its series. If similar elements of a series contain n_1, n_2, n_3 ... electrons per atom, and if A_1 ... be their atomic weights; and if we assume $n \propto A$; then $n_1 = \beta A_1$, $n_2 = \beta A_2$, &c. The volume of the positive sphere is $4\pi r_m^3/3$; that of each of the n_m electron fields is e/ρ; $\therefore 4\pi r_m^3/3 = n_m v = \beta v A_m$, and similarly for $(m+1)$; whence $(4\pi/3\beta v)^{1/3}.(r_{m+1} - r_m) = A_{m+1}^{1/3} - A_m^{1/3} = C$, where C should be the same for all series of similar elements. Also $(r_{m+1} - r_m)^3 = v$ approximately, so that $\beta = 4\pi/3C^3$. If this be so, we ought to be able to find the number of electrons per atom from the atomic weights. It is found on plotting out values of $A^{1/3}$ for the periodic series, that the values of $A^{1/3}$ for each series fall nearly on straight lines, and that the different lines are nearly parallel. Therefore $A_{m+1}^{1/3} - A_m^{1/3} = C$ *ut supra*, nearly; and C is about 0·81. Hence $\beta = 8$, and the number of electrons per atom comes out about 8 times the atomic weight in all cases. This agrees sufficiently with the evidence from scattering. If we take $n_1 = 8$, we get the following values of n_m for $m = 1, 2, 3, 4, 5, 6$ respectively; H 8, Li 47, Na 142, K 320, Rb 600, Cs 1020; whence, dividing by 8, we would get calculated atomic weights H 1, Li 6, Na 18, K 40, Rb 75, Cs 128. For an approximate calculation these coincide sufficiently with the observed 1, 7, 23, 39, 85, 133. A. D.

1321. *Relation of Temperature and Molecular Attraction.* **J. E. Mills.** (Phil. Mag. 22. pp. 84–118, July, 1911.)—In a series of papers R. D. Kleeman has investigated a possible "fifth power" law of the molecular attraction, using in his investigation data from a paper by the present author. But in so doing it was apparently overlooked that those data were used by the author to prove an equation theoretically derived on the supposition of the "inverse square" law. The present paper presents tabulated data occupying eleven pages. These the author discusses, and on the assumption of the inverse square law, reaches the conclusions: (1) that change of temperature does not change the nature or the amount of the molecular attractive force, and (2) that the temperature merely determines the orbit that the molecules will follow in obedience to the attractive force. [See Abstracts Nos. 765, 766, 1199 (1910); 17, 20 (1911).] E. H. B.

1322. *Deformation of Rocks under Tidal Load.* **J. Milne.** (Nature, 87. p. 44, July 13, 1911.)—A seismograph installed at Ryde, 188 ft. from high-water mark, showed a tilting of 0·9 seconds of arc for a 10-ft. tide. Comparing the result with some previously obtained at Bidston, it is probable that the soft tertiary rocks beneath the Solent yield more under tidal load than do the hard sandstones which run seawards from Bidston. The author draws attention to the possibility of deriving from such results information as to the elastic character of the earth's crust and the lunar tide in the solid earth. **C. Chree.** (Ibid. pp. 76–77, July 20, 1911.)—Chree questions how far the total effect obtained by Milne is really due to pressure and how much is due to the large additional quantity of gravitating material present at high tide. The two effects are best separated by measurement of the apparent slope in two perpendicular planes, as the vertical plane of steepest slope at any place must contain the direction of the resultant gravitational force if the material be homogeneous. Moreover, while a gravitational effect must be instantaneous the bending effect will probably show a certain lag. The author also gives a solution he has obtained for the vertical component of the elastic displacement produced by a load on the surface of a solid material which is homogeneous and isotropic. A. D. R.

REFERENCES.

1323. *Elasticity Theories and Relativity Principle.* **M. Born.** (Phys. Zeitschr. 12. pp. 569–575, July 15, 1911.)—Does not aim at giving a complete theory of elasticity on the relativity principle, but a partial treatment on the lines indicated by Minkowski. The paper is highly analytical and unsuitable for detailed abstraction. E. H. B.

1324. *Ideal Experiments on the Relativity Principle.* **F. Grünbaum.** (Phys. Zeitschr. 12. pp. 500–509, June 15, 1911.)—Following the suggestion of H. v. Mangoldt [see Abstract No. 1589 (1910)] the present author imagines, by an extension of the principle, views taken by observers in the resting and in the moving systems. The paper is illustrated by diagrams and is largely mathematical. E. H. B.

1325. *Bearing of the Principle of Relativity on Gravitational Astronomy.* **W. de Sitter.** (Roy. Astronom. Soc., M.N. 71. pp. 388–415, March, 1911.)

1326. *Structure of Upper Atmosphere.* **A. Wegener.** (Phys. Zeitschr. 12. pp. 170–178, March 1, 1911.)—The various observations which have obtained currency concerning the composition of the upper atmosphere are reviewed, and a new diagram given showing the author's computation of the composition of the air at various levels from 0 to 500 km. above the ground. C. P. B.

1327. *Coronal Structure.* **C. Störmer.** (Comptes Rendus, 152. pp. 571–575, March 6, 1911.)—In a former note [Abstract No. 783 (1911)] the author has discussed the problem of the structure of the coronal rays on the assumption that the sun is surrounded by a magnetic field. In the present paper he supposes that the corpuscles are subject to gravitation, to a uniform electric charge, and to the repulsion of light-pressure. C. P. B.

1328. *Radial Velocity of a Cygni.* **G. Neuimin.** (Mitt. d. Nikolai Hauptsternwarte zu Pulkowo, No. 38. Nature, 86. p. 394, May 18, 1911. Abstract.)—The variable velocity of *a* Cygni was announced from the Yerkes and Lick Observatories in 1910, and observations made at Pulkowa now confirm this; the metallic lines and the hydrogen lines give different velocities. C. P. B.

LIGHT.

1329. *The Refractive Index of Water.* **G. P. Baxter, L. L. Burgess, and H. W. Daudt.** (Amer. Chem. Soc., Journ. 33. pp. 893–901, June, 1911.)—As the result of this research, in which special attention was paid to the purity of the water and to the exact regulation of temperature, the index of refraction of water for sodium light was found to be :—

	Referred to Air at the same Temperature.	Referred to Vacuum.
At 20° C.	1·33299	1·33335
At 25° C.	1·33248	1·33284
At 30° C.	1·33190	1·33225

T. M. L.

1330. *Aberration in a Dispersive Medium.* **Rayleigh.** (Phil. Mag. 22. pp. 130–134, July, 1911.)—The application of the theory of group-velocity to the case of light was discussed in an early paper (Nature, 1881; Scientific Papers, vol. i., p. 537) in connection with some experimental results announced by Young and Forbes, who concluded that blue light travels *in vacuo* 1·8 per cent. faster than red light. It seems now generally agreed that whether the method be that of the toothed wheel or of the revolving mirror, what is determined by the experiment is not V, the wave velocity, but U, the group velocity, where $U = d(kV)/dk$, k being inversely as the wave-length. In a dispersive medium V and U are different. Jupiter's satellites would also give U. But it was thought that, on the usual theory, aberration would correctly give V, the wave velocity. This statement that stellar aberration gives V rather than U has, however, in the light of modern theory, been questioned by Ehrenfest (Ann. d. Physik, 33, p. 1571, 1910). After a general and an analytical examination of the case the present author agrees that the aberration angle is v/U. E. H. B.

1331. *Variation in Transparency of Quartz for Ultra-violet Light. Dissociation of Matter.* **G. Le Bon.** (Comptes Rendus, 153. pp. 49–51, July 3, 1911.)—The fact recently recorded by Courmont and Nogier that quartz lamps subjected to the action of Hg vapour gradually become opaque to ultra-violet rays [Abstract No. 1388 (1911)] is claimed to have been discovered several years ago by the author, who also found that the production of a spark between electrodes of Au, Pt, or Cu in a quartz vessel had the same effect on the quartz. Their experiments showing the intensity of the chemical action of ultra-violet light recall the author's experiments [Abstract No. 88 (1908)] on the radio-activity produced by the action of sunlight on various bodies. Radio-activity is regarded as a universal property of matter, in some cases being spontaneous, in others requiring the influence of light to induce it, certain alloys then becoming 40 times as active as uranium. W. H. St.

1332. *Terrestrial Translation and Optical Phenomena.* **L. Giuganino.** (Comptes Rendus, 152. pp. 1662–1664, June 12, and pp. 1829–1831, June 26, 1911.)—The electromagnetic theory of light, developed by H. A. Lorentz, introduces a relation, discovered by Fresnel, between the velocity of propagation of light in a transparent medium, the index of refraction, and the velocity of translation of this medium. This relation explains well enough the *partial entrainment of the waves* observed by Fizeau and by Michelson and Morley. In this note the present author applies this formula to the study of the phenomena which may be expected to occur in a case of reflections at an angle of 45° of two parallel rays, one traversing a thin plate before reflection and the other ray a thin plate after reflection. The assumption is here made, according to Lorentz, that the ether is not, even partially, entrained by the movement of the earth. **G. Sagnac.** (Ibid. pp. 1885–1888, June 26, 1911.)—Sagnac criticises the methods and conclusions of Giuganino. **E. H. B.**

1333. *Orientation of Liquid Crystals by the Magnetic Field.* **C. Mauguin.** (Comptes Rendus, 152. pp. 1680–1684, June 12, 1911.)—Azoxyanisol in the liquid-crystal state sets itself with an optic axis perpendicular to the surface of clean glass plates in layers up to a max. thickness of 0·2 mm. Thicker layers are oriented irregularly, but set themselves to a homogeneous liquid-crystal under the influence of a magnetic field of 2500 units, breaking down again when the field is removed; in this way layers up to 1 to 2 mm. may be controlled, the optic axis being parallel to the magnetic lines of force. In layers 0·01 mm. thick the axis is dominated by the glass plates, but can be rendered somewhat oblique by fields up to 7000 units without being drawn into the perpendicular position. **T. M. L.**

1334. *Expenditure of Energy necessary to produce the Unit of Luminous Intensity.* **H. Buisson and C. Fabry.** (Comptes Rendus, 153. pp. 254–255, July 24, 1911.)—An Heraeus lamp is employed, and the radiations studied are the violet 4358, the green 5460, and the group of two yellow radiations 5780. The photometric measurements are carried out by means of a Lummer photometer, and a Hefner lamp is taken as standard. The green radiation 5460 occurs just in that region of the spectrum which produces, with equal energy, the strongest impression on our eyes. The value 0·018 watt per candle found for this radiation therefore corresponds to the minimum possible expenditure of a lamp which entirely transforms the energy it receives into the most advantageous luminous radiations. The luminous intensity under these conditions would be 55 candles per watt. Different values, ranging from 17 candles per watt (Drysdale) to 72 candles per watt (Hyde), obtained by indirect methods, have already been given for this quantity, which is sometimes designated the mechanical equivalent of light. For the yellow radiation 5780 the number of watts per candle is slightly smaller than for the green; the yellow radiation, however, contributes an important part of the light of the mercury lamp. As to the violet radiation, although mercury lamps emit it with an intensity comparable with that of the green ray, it only contributes to the lighting in an insignificant manner owing to the very feeble sensitivity of our eyes. **A. E. G.**

1335. *Effect of Atmospheric Conditions on Photometric Flame Standards.* **W. J. A. Butterfield, J. S. Haldane, and A. P. Trotter.** (Electrician, 67. pp. 711–713, Aug. 11, 1911. Abstract of paper read at meeting of the Internat. Photometric Commission, Zurich, July, 1911. Illum. Engin., London, 4. pp. 509–518, Sept., 1911.)—In previous researches on this subject the difficulty has been that the various influential factors (humidity, barometric pressure, presence of CO$_2$, &c.) vary simultaneously and cannot be dissociated. In practice atmospheric conditions only fluctuate comparatively slightly over considerable periods of time; a large number of readings are therefore needed, and the resulting accuracy is mainly dependent on a few exceptional determinations. The authors have therefore adopted the method of examining these effects in a closed chamber, within which the pressure, humidity, &c., could be varied independently within wide limits and in quite a short space of time. Details are given of the electrical arrangements for controlling the glow-lamp used as a substandard, and the methods of determining the atmospheric conditions. The results for the Harcourt Pentane lamp are in satisfactory accordance with those of Paterson and are recorded in a diagram. The effect of humidity on the Hefner and Harcourt lamps is also in fair agreement with that ascertained both by Paterson and Liebenthal. But the effect of changes in barometric pressure on the Hefner lamp is found to exceed that given by Liebenthal; a variation in pressure of 10 mm. alters the light by 0·4 per cent. The results of experiments on the effect of vitiation of the atmosphere are also given. In conclusion complete formulæ are given enabling both the Hefner and Harcourt lamps to be corrected for changes in barometric pressure, humidity, and vitiation of the atmosphere. J. S. D.

1336. *Spectrophotometric Investigation of the Opalescence of a One-component Substance in the Neighbourhood of the Critical State.* **W. H. Keesom.** (Ann. d. Physik, 35. 3. pp. 591–598, July 11, 1911.)—Quantitative measurements were made of the light scattered by liquid ethylene at six temperatures over a range of 2·85° above the critical temperature (11·18° C.) of the not quite pure material. The amount of scattered light was inversely proportional to the temperature-interval from the critical-point, and could be represented by a hyperbolic curve. This is in agreement with the theory of Smoluchowski [Abstract No. 1587 (1908)] that the opalescence is dependent on density-differences dependent on variations of molecular motion as assumed by Boltzmann and Gibbs. A second series of measurements were made for two wave-lengths (D and F); the ratio λ_D^4/λ_F^4 was lower than the value 2·13 given by Rayleigh for light scattered by particles small compared with the wave-length, especially at the lower temperatures, but at temperatures 0·7° and more above the critical-point the difference is not large, and the optical behaviour is practically that of a system of small suspended particles.

T. M. L.

1337. *Law of Blackening of Normal Lighting, and Photographic Spectral Photometry.* **J. Stark.** (Ann. d. Physik, 35. 3. pp. 461–485, July 11, 1911.)—If S represents the blackening of a developed photographic layer, i the intensity of the incident light in arbitrary units, t the duration of constant lighting, then $S = \log (ki^m t^n)$ where k, m, and n are constants for small variations of i and t. The object of the paper is in the first place to establish in what proportion i and t may vary without causing any marked alteration in m and n, and in the second place to ascertain how k varies, and the dependence of m and n on the wave-length. The method adopted differs from that of previous observers in that light of definite wave-lengths is employed. The light of wave-lengths λ5461 and λ4359 obtained by means of mercury lamp is chosen. It is found that the time exponent n of normal blackening is greater for the line λ5461 than for the line λ4359 and that, further, it is in general a function of the wave-length. The intensity exponent m of normal blackening is a function of the wave-length and is greater for λ5461 than for λ4359. The exponent *n* is independent of the intensity over a range of variation of intensity greater than 1 : 1600. It is further shown for the Lumière plates used, that the values of *k*, *m*, and *n* for homogeneous light are independent of the intensity over a range of intensity-variation of 1 : 100. The paper closes with a discussion of the Schwarzschild blackening law and the spectral photometric researches of P. P. Koch. **G. Leimbach.** (Ibid. 36. 1, pp. 198-202, Oct. 3, 1911.)—A criticism. A. E. G.

1338. *Development of Photographic Images after Fixing.* **A.** and **L. Lumière** and **A. Seyewetz.** (Comptes Rendus, 153. pp. 102-104, July 10, 1911.)—Neuhauss has shown that it is possible to develop the latent photographic images upon gelatino-bromide of silver plates after these have been fixed in hyposulphite of soda. His method, however, can only be employed when the plate has been exposed twenty times the normal time required by ordinary methods of development. It is now shown that the best bath for fixing is a 2 per cent. solution of hyposulphite of soda. When this is used slow plates only need four times, and rapid plates six times the normal exposure. The double sulphite of silver and sodium is found to give the best results as developer. An attempt is also made to replace the salts of silver by other metals whose sulphites are soluble in an excess of sulphite of sodium. Mercury alone appears to give interesting results. In certain cases its salts seem preferable to salts of silver because they give less dichroic and more opaque images. Full working formulæ are given for both silver and mercury developers. A. E. G.

1339. *Spectroscopic Investigations in connection with the Active Modification of Nitrogen.* I. *Spectrum of the Afterglow.* **A. Fowler** and **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 85. pp. 377-388, July 5, 1911.)—The method of producing and isolating the nitrogen afterglow adopted in the observations dealt with in the present paper has been previously described [see Abstract No. 1210 (1911)]. As seen and photographed with instruments of small dispersion, the spectrum of the afterglow produced by that method appears to be identical with that described by Lewis [Abstract No. 2544 (1904)]. The luminosity, however, is so great, and its maintenance so easy, that considerable dispersion may be employed, and long exposures given, so that the spectrum can now be examined in much greater detail. A detailed account is given of the spectrum of the afterglow of pure nitrogen, with wave-length determinations of sufficient accuracy to indicate the series relationships of the various bands. The characteristic bands of the afterglow in the red, yellow, and green are complex groups which have been found to be identical with some of the bands forming the sequence known as the first positive group of nitrogen. They represent a special development of three of the numerous series into which the first positive bands have been divided. The second group of afterglow bands, extending from 4812 to 2508, corresponds with a group of faint bands which occur in the uncondensed discharge in air or nitrogen, and the third group is identical with the third positive group of nitrogen bands, as previously shown by Lewis. The most characteristic feature of the condensed discharge which produces the afterglow is a series of seven complex bands, occupying the region 2904 to 2256, which have not previously been recorded as belonging to nitrogen. It is suggested that these should be designated the "fourth positive" group of nitrogen bands. No afterglow is excited when the discharge is such as to give only the line spectrum of nitrogen. A. E. G.

1840. *Mineral Constituents of Dusty Atmosphere.* **W. N. Hartley.** (Roy. Soc., Proc. Ser. A. 85. pp. 271–275, June 9, 1911.)—Series of spark spectra were photographed with a small quartz spectograph, the electrodes being generally cadmium, and self-induction being inserted to eliminate the air spectrum and the short metallic lines. It was found that many lines appeared in the photographs other than those due to the metallic electrodes employed. It was proved that these lines did not originate from impurities in the metal, since the same electrodes with longer exposures in an atmosphere of hydrogen gave spectra without these impurity lines, which must consequently be due to solid matter in suspension in the atmosphere being vaporised by the spark. Elements identified from these lines, which are principally the ultimate lines of the elements, include the following: Ca, C, Pb, Mn, Ni, Cu, Mg, Fe. As no atmosphere is free from dust, and that of cities is particularly dusty, these mineral constituents must be regarded as possible reagents in cases where there is evidence that very minute quantities of basic substances can initiate chemical reactions and isodynamic changes, such as have generally been considered as spontaneous, and in all cases where a solution in contact with air is liable to be affected. A. W.

1841. *Vacuum Tube Spectra of Mercury.* **F. Horton.** (Roy. Soc., Proc. Ser. A. 85. pp. 288–302, June 9, 1911.)—The vacuum tubes used in this research were prepared with great care, and all gave similar spectra, but in one or two the CO band spectrum was sometimes seen after they had been in use for some weeks. The vacuum was so complete that at ordinary temperatures no discharge could be sent through the tubes by a 10-in. spark coil. The experiments described go to prove that mercury is capable of giving several distinct line-spectra when subjected to an electric discharge in a vacuum tube. The five-line spectrum is the one most easily produced, and as the energy is increased or the pressure of the vapour is diminished, the other spectra recorded in the tables make their appearance in turn. The spectra of Table I. are all perfectly definite in appearance, not only in regard to the actual lines they contain, but also as to their relative intensities when the spectrum is fairly bright; moreover, on gradually increasing the energy of the discharge, all the lines of each spectrum in turn appear at the same moment as the electrical conditions become suitable to its production. The many-lined spectrum, on the other hand, is not quite so definite, for the number of lines appearing increases as the energy of the discharge is increased, until all are present. This is well illustrated by the case of the electrodeless ring discharge, in which the complete many-lined spectrum is only seen in the stronger parts of the field. A similar result can be obtained with the ordinary vacuum-tube discharge in which the electrical intensity is different at different points. It is much greater in the capillary portion than in the wider parts of the tube; and consequently, when the complete many-lined spectrum is seen in the capillary, there may be fewer lines in the spectrum of the luminosity at other places. This is the result obtained by Huff [Abstract No. 2418 (1900)]. Huff came to the conclusion that the change from the spectrum with fewest lines to that with the greatest number is quite gradual. This is so when we are dealing with the many-lined spectrum all the time, but this gradual change does not occur in the case of the spectra of Table I., all of which contain many fewer lines. It is seen from the tables that the five lines of Spectrum I. are common to all the spectra of mercury, although their relative intensities are not always the same. The spectrum of the glowing lime discharge consists of these *plus* some others, the brightest being the three lines in the orange region. Spectrum III. is practically a combination of Spectra II. and IV. together with a few extra lines, the brightest of which is 5868. There are seven lines of Spectra II. and IV. which do not appear in III., but all are of very small intensity. The many-lined spectrum contains all the lines of the other spectra, except the five red and orange lines 6908, 6717, 6235, 6124 and 6074. These, though sometimes visible, were always absent when the spectrum was at its best. The author points out the importance, from a spectroscopic point of view, of two of the methods of producing luminosity in a gas which have been employed in these experiments, namely, by using the electrodeless ring discharge, and by the discharge from a glowing lime kathode. The first of these is a very convenient way of obtaining the spectrum with most lines, corresponding to that given by a heavy discharge with capacity in the circuit. The latter method of exciting luminosity is one which should be capable of many applications in spectroscopy, on account of the ease with which the electrical conditions can be controlled. [See also Abstract No. 1210 (1905).] A. W.

1342. *Origin of Spectra.* **F. Horton.** (Phil. Mag. 22. pp. 214–219, July, 1911.)—In a recent paper [see preceding Abstract] the author has given an account of some experiments with mercury vacuum tubes, which show that mercury is capable of giving several distinct line spectra when rendered luminous by an electrical discharge. The particular spectrum appearing in any given case depends on the energy of the discharge in relation to the mass of vapour through which it passes. The spectrum most easily produced consists of five bright lines, but as the energy of the discharge is increased other spectra make their appearance in turn. Reasons can be given for thinking that these more complicated spectra are due to the formation of definite electronic systems, which are practically unstable new substances formed from the normal mercury atoms by the passage of the discharge, and that they are not due merely to different modes of vibration of the electrons in some one system—such, for instance, as the mercury atom. Stark's views on the origin of spectra [Abstract No. 1210 (1905)] are dealt with, and the author's research supports Wien's criticism [Abstract No. 2100 (1909)] of Stark's views. The fact that compounds always give banded spectra would seem to indicate that these are due, not to electrons, but to the vibrations of larger bodies. Since they produce light of the same wave-length, these larger bodies must be under the influence of more intense forces, which suggests that they are not separate atoms, but systems of atomic dimensions vibrating inside the molecule itself. On these views of the origin of line and of band spectra we should expect that a gas or vapour consisting solely of molecules in a normal condition would give a band spectrum—a conclusion which is borne out by the fact that the absorption spectra of such gases always consist of bands. In the case of the vapours of the alkali metals, which give line spectra, we have molecules which are not in a "normal" condition, as is shown by the abnormal conductivity of these vapours. The researches of various investigators, Ladenburg, Pflüger, H. B. Baker, and others, are instanced as showing the difference in composition of a gas in its ordinary state and when rendered luminous by an electric discharge, thus supporting the author's theory that ionised gases and vapours possess electronic systems not present in them in the normal state. Recent work of Thomson [Abstract No. 858 (1911)] has shown that the carriers of positive electricity in a vacuum tube are often more complex than the original gas or vapour through which the discharge is passing. Thus in the case of oxygen gas, carriers of positive electricity with "electric atomic weights" of 8, 16, 32, 48, and 96 have been discovered. From this an explanation of the low-pressure band spectrum of oxygen is given with reference to the author's theory. The mercury spectrum is also dealt with in the light of Thomson's research, with satisfactory conclusions. A. W.

1343. *Band Spectrum of Glucinum in different Luminous Sources.* **L. de Boisbaudran and A. de Gramont.** (Comptes Rendus, 153. pp. 318–321, July 31, 1911.)—With the arrangements previously described [Abstract No. 1898 (1909)] and using a Rutherford flint prism spectrograph the authors have discovered a third band in the glucinum spectrum. This new band is in the indigo, is much weaker than the other two previously known, and can only be seen with difficulty. Wave-length tables are given for all three bands, together with intensities as obtained on Wratten plates specially sensitised for green. These bands are well developed in the spectra of the blow-pipe flame, especially the oxy-acetylene flame, by introducing gradually a piece of filter-paper washed with acid and impregnated with glucinum chloride. The bands have been observed with the same relative intensities in the electric arc, and also in the spark spectrum, especially if a condenser (about 0·005 mfd.) is introduced into the secondary circuit of the coil. There is a striking similarity between the band spectrum of glucinum and that of aluminium. The bands Gl β 5056·4, α 4709·0, γ 4428·0 correspond respectively to the bands Al β 5079·5, α 4842·4, γ 4648·1, and the relative intensities are the same. The ultimate doublet Gl 3131·2, 3130·5 corresponds also to that of Al 3961·7, 3944·2. A. W.

1344. *Apparent Softening of Röntgen Rays in Transmission through Matter.* **C. A. Sadler and A. I. Steven.** (Phil. Mag. 21. pp. 659–668, May, 1911.)—A heterogeneous beam of Röntgen rays was obtained from an X-ray tube having a thin Al window. This beam was allowed to produce an ionisation current in an electroscope, and the percentage diminution of the ionisation, caused by the introduction of a sheet of Al in the path of the beam, was observed. A thin sheet of iron was then placed in the path of the beam, and the percentage diminution of the resulting ionisation, caused by the introduction of the same sheet of Al, was found to be greater than with the previous arrangement, thus indicating a softening of the beam caused by transmission through the iron. Further experiments showed this to be due to a selective absorption of the constituent rays of the heterogeneous beam by the iron, the rays absorbed being those which can readily excite the characteristic homogeneous radiation of iron. Similar results were obtained with other substances. E. M.

1345. *Production and Properties of Soft Röntgen Radiation.* **R. Whiddington.** (Roy. Soc., Proc. Ser. A. 85. pp. 99–118, April 11, 1911.)—The paper gives a fuller account of the preliminary experiments described in Abstract No. 78 (1911). The author has studied the properties of Röntgen radiation produced in an X-ray tube, with a thin Al window, using different anti-kathodes and different generating potentials. He finds that the behaviour of Al and Pt (Group A) towards either the kathode rays or the soft Röntgen radiation produced in these experiments, is very different from the behaviour of Ag, Cu, Cd, Fe, Ni, Pb, Sn or Zn (Group B). At a definite generating potential the radiations from members of Group B used as antikathodes are found to differ among themselves only in quantity (ionising power) and not in quality (absorption coefficient). The quality, however, does depend on the generating potential. The author regards the radiations from anti-kathodes of Al or Pt, on the other hand, as containing, in addition to a component whose quality depends on the generating potential, a part containing relatively strong constituents of the characteristic type for the metal, these characteristic types being also peculiar in that they can be stimulated or produced by less penetrating Röntgen rays. This latter hypothesis corresponds to Wood's discovery of the limited applicability of Stokes' law. The author also shows that Al and Pt under the impact of soft Röntgen rays emit corpuscular radiation in addition to the above-mentioned characteristic secondary Röntgen radiation. In this respect Al and Pt are differentiated from members of Group B, which do not emit under similar circumstances any measurable quantity of charged particles. E. M.

1346. *Attempt to Detect Diffusion in a Pencil of Röntgen Rays.* **J. A. Crowther.** (Cambridge Phil. Soc., Proc. 16. pp. 177–188, May 18, 1911.)—It has been shown [see Abstract No. 477 (1911)] that there is a lack of symmetry in the scattered radiation which is not to be expected from the simple theory of the phenomenon. The form of the experimental curve suggests that the radiation measured is of two kinds: (1) the true scattered radiation distributed according to the theoretical formula; (2) a superposed radiation from some other source, the intensity of which diminishes continually as we get further away from the forward direction of the primary beam. If two sources of radiation exist, the type of rays they cause to be emitted must be the same, as there is no appreciable difference in the absorbability of the forward and backward radiation. Experiments now made on the scattered Röntgen radiation from a radiator in directions very close to the primary beam, show that the distribution of the scattered radiation is not consistent with the supposition that the dissymmetry observed in the distribution is due to an irregular refraction of the primary beam by the atoms of the radiator. In attempts made to influence the distribution of the scattered radiation by a strong magnetic field (2500 gauss) no difference can be detected between readings taken with the field off and on. Similarly, with electric fields up to 22,500 volts per cm. no difference can be detected in the scattered radiation with and without the field. Further experiments are in progress. A. E. G.

1347. *Scattering of α- and β-Particles by Matter, and the Structure of the Atom.* **E. Rutherford.** (Phil. Mag. 21. pp. 669–688, May, 1911.)—It has generally been supposed that the scattering of a pencil of α- or β-rays in passing through a thin plate of matter is the result of a multitude of small scatterings by the atoms of matter traversed. The observations of Geiger and Marsden, however [Abstract No. 1548 (1909)], suggest that α-particles can suffer a deflection of more than a right angle at a single encounter. The present paper deals mainly with the theoretical examination of a single encounter of an α- or β-particle with an atom of simple structure which is able to produce large deflections owing to the electric forces associated with it. The author finds that an atom with a strong positive or negative central charge concentrated within a sphere of less than 8×10^{-12} cm. radius, and surrounded by electricity of the opposite sign distributed throughout the remainder of the volume of the atom of about 10^{-8} cm. radius, satisfies all the known laws of scattering due to either α- or β-rays. In considering the deflection of an α-particle directed against such an atom of matter the whole deflection effect can be supposed due to the central concentrated charge which will cause the α-particle to describe an hyperbola with the centre of the atom as external focus; the angle between the directions of the α-particle before and after deflection depending on the perpendicular distance between the centre of the atom and the initial line of fire of the α-particle. Thus, assuming a narrow pencil of α-particles directed against a thin sheet of matter containing atoms distributed at random throughout its volume; if the scattered particles are counted on a zinc sulphide screen distant r from the point of incidence of the pencil in a direction making an angle ϕ with it, the number of scintillations appearing per unit area of the screen is deduced to be proportional to (1) $\operatorname{cosec}^4(\phi/2)$, (2) thickness of scattering material if this is small, (3) magnitude of the central charge of the atoms, (4) the inverse fourth power of the velocity of the incident α-particles. (2) and (3) are found to be in excellent agreement with Geiger and Marsden's experiments, assuming the central charge of an atom to be proportional to its atomic weight, and from the experimental data it is calculated that the central charge necessary is a number of elementary charges equal to half the atomic weight of the atom. Some preliminary experiments of Geiger have also shown that (1) holds substantially for deflections between 30° and 150°.

The author next considers the effect of α-particles receiving a number of deflections by different atoms, and shows that this effect would be pronounced at small angles, whence he deduces the laws found by Geiger [Abstract No. 1248 (1910)]; and the numerical results agree with the idea of the central charge being about half the atomic weight. With regard to β-rays the above laws should still hold, although, owing to their small mass, β-rays are much more easily deflected than α-rays. The author shows that the results of Crowther and Schmidt [Abstracts Nos. 1440 and 1607 (1910)] are in substantial agreement with the above idea of atomic scattering. [See also Abstract No. 1470 (1910).] E. M.

1348. *Probability Distribution of the Time-intervals of α-Particles; Application to Number of α-Particles emitted by Uranium.* **E. Marsden** and **T. Barratt.** (Phys. Soc., Proc. 23. pp. 367–378, Aug., 1911.)—In counting the α-particles from radio-active substances by the scintillation method the great preponderance of short intervals is very noticeable, especially when the scintillations are appearing at a slow rate. This preponderance leads us at first sight to consider the α-particles as coming in groups and not distributed according to a simple probability law. Rutherford and Geiger (Abstract No. 849 (1911)] examined the emission of α-particles from polonium from this point of view. Their results were in good agreement with a theoretical formula given by Bateman. However, were the particles given off in equal groups and the groups distributed in time according to probability, it is conceivable that Bateman's formula would still hold. It therefore seems preferable to test the application of the probability laws to actual time-intervals between successive α-particles, and to count the whole number from a given source instead of only those emitted within a relatively small solid angle. The problem of the calculation of the distribution of time-intervals is considered, and the formula obtained is applied to observations on α-particles from polonium and uranium, and found to agree well with experimental results. The variations of the intervals between the emission of successive α-particles from both polonium and uranium thus show good agreement with simple probability theory, and it is concluded that the two α-particles from

Ur are not given off simultaneously. Further, if they are given off by successive α-ray products the period of the second must be greater than a few seconds. This is also unlikely because of the small ranges of both sets of α-particles. Further experiments are in progress. In an addendum experimental results obtained by Rutherford and Geiger are compared with calculated values, and the agreement between them is found to be satisfactory.

A. E. G.

1349. *β-Rays of Radium Products.* **J. Danysz.** (Comptes Rendus, 153. pp. 339–341, July 31, 1911.)—The author has examined the magnetic spectrum of the β-rays from RaEm (in equilibrium to RaC) contained in a very thin glass tube. Seven separate homogeneous bands were observed corresponding to the following velocities in terms of the velocity of light: (1) 0·98, (2) 0·95, (3) 0·86, (4) 0·81, (5) 0·75, (6) 0·69, (7) 0·63. [See Abstract No. 1710 (1910).]

E. M.

1350. *Nature of γ-Rays.* **T. H. Laby** and **P. Burbidge.** (Nature, 87. p. 144, Aug. 3, 1911.)—It is known that the ionisation produced by α- and β-particles is subject to slight fluctuations due to the probability variations of the finite number of ionising particles [Abstract No. 926 (1908)]. The authors have observed similar effects with γ-rays. A box-shaped ionisation can was provided with a central electrode. By arranging the electric fields, the positive ions formed in one half of the can were received on one side of the flat electrode, and the negative ions from the other half of the can on the other side of the electrode, so that the charges neutralised each other. Large fluctuations were observed when the source of γ-rays was placed in the plane of the electrode outside the can. This experimental result would be explained if (1) the γ-rays from Ra are projected particles or (2) if the number of ions produced in air by a constant source of γ-rays is subject to fluctuations.

E. M.

1351. *Complex Nature of RaC.* **K. Fajans.** (Phys. Zeitschr. 12. pp. 369–377, May 15, 1911.)—The author has investigated more completely the result of Hahn and Meitner that what is ordinarily known as RaC is really complex; and the results show that the changes occurring in it are also irregular. The method of experiment was the examination of the rays and periods of the products obtained by back-kick from pure RaC. The RaC was generally prepared as follows: A large quantity of RaEm was kept several hours in a glass tube. After removal of the emanation the tube was washed out with alcohol to remove the last traces of the gas, and afterwards the active lining was washed off with hot concentrated HCl. After waiting an hour, so that the RaA had decayed to less than 10^{-6} of the original amount, the solution was diluted and the RaC extracted by deposition on a nickel plate. With this source the back-kick product was obtained in the usual way on a plate placed 0·5 mm. away at atmospheric pressure with a p.d. of 100 volts. The results show that RaC_1 with half-time period 19·5 min. gives rise to RaC_2 with half-time period 1·38 min. ($\lambda = 0{\cdot}0084$ sec.$^{-1}$). RaC_1 was shown to give out α-rays, and RaC_2 β-rays whose coefficient of absorption, within the error of experiment, agreed within 5 to 10 per cent. of that of the β-rays from ordinary RaC. However, the fraction of the atoms of RaC_1 which could be made to give RaC_2 on the recoil plate was very small—smaller even than in the case of a β-ray recoil. Again, the amount of RaD which could be obtained by back-kick from RaC was such as to indicate an α-ray recoil, so that RaD cannot arise directly from RaC_2 which emits no α-rays; nor, owing to the small amount of RaC_2 which recoils from RaC_1, can it have grown from the recoiled RaC_2 atoms. These and other experiments point to the conclusion that RaC_1 decomposes simultaneously in two directions as follows:—

$$\begin{tikzcd}[column sep=small, row sep=tiny]
 & & & & & RaC_2 & & \\
Ra \arrow[r] & Em \arrow[r] & RaA \arrow[r] & RaB \arrow[r] & RaC_1 \arrow[r] \arrow[ru] & RaD \arrow[r] & RaE \arrow[r] & RaF.
\end{tikzcd}$$

It seems probable that the number of RaC_1 atoms which give rise to atoms of RaC_2 is small, and it is possible that RaC_2 may be the parent of the actinium family. E. M.

1852. *Ionising Radiation emitted by RaC.* **L. Wertenstein.** (Comptes Rendus, 152. pp. 1657–1660, June 12, 1911.)—The author has investigated the very easily absorbed radiation which produces ionisation in the immediate neighbourhood of a source of RaC. The source was placed in a vessel such that the pressure could be altered, and under suitable conditions the radiation could be made several times more effective in producing ionisation in the apparatus than the α-rays from the RaC. The radiation in question was found to be undeviated to any appreciable extent by strong magnetic fields, and its penetrating power was similar to that of the recoil atom of RaB from RaA [see Abstract No. 1601 (1910)], and the author therefore concludes that it consists of the projection of RaD by RaC. E. M.

1853. *Coefficient of Absorption by Air of the β-Rays from Radium C.* **A. S. Eve.** (Phil. Mag. 22. pp. 8–17, July, 1911.)—The object of the paper is to describe a new method of finding the value of μ, the coefficient of absorption of the β-rays from RaC in their passage through air at atmospheric pressure and at room temperature. The general method employed is as follows: A very thin-walled electroscope is suspended by fine wires at a considerable distance from the surrounding objects. A test-tube containing radium bromide is also suspended at various distances from the electroscope. The ionisation current in the electroscope is due to the joint effects of the β-rays, γ-rays, and natural leak. The β-rays are then cut off by screens, or by a strong magnetic field, or better still by both methods, and the ionisation due to γ-rays and natural leak is measured. As the natural leak is known, by subtraction measurements are obtained of the ionisation due to the β-rays alone, and to the γ-rays alone. By varying the distance r between the Ra and electroscope, it is found that the law of absorption by air of the complex rays from RaC is approximately exponential. If I is the ionisation due to β-rays in the electroscope at a distance r from the Ra, then Ir^2 varies as $\epsilon^{-\mu r}$ nearly. The values of μ have been found as 0·0088 cm.$^{-1}$ at the shorter ranges 60 to 160 cm., and 0·0045 at longer ranges 2 to 5 m. If air absorbs β- and γ-rays respectively in the same proportion as does Al, the coefficient of absorption of the γ-rays by air is between 0·000021 and 0·000081. With limitations, the average effective range of the β-rays from their source may be stated as 2·5 m. In the same sense the average path of the γ-rays is 250 m., if the γ-rays consist of entities with linear paths. In an appended note it is stated that measurements of μ made when β-rays from the active deposit of Ra on thin Al-foil, pass to a thin-walled electroscope through air at ranges from 40 to 100 cm., are about 8 or 4 times as large as when Ra in a glass tube is employed at longer ranges. The explanation appears to be that RaC emits a considerable proportion of slow β-rays, comparable to those from RaB; but this point requires further investigation. Further work on β-rays from the active deposit of thorium is in progress. The value 0·024 to 0·025 has been found for μ in some preliminary experiments. A. E. G.

1354. *Behaviour of Radium Emanation at Low Temperatures.* **R. W. Boyle.** (Phil. Mag. 21. pp. 722–732, June, 1911.)—The experiments of Rutherford, and Gray and Ramsay [Abstracts Nos. 1684 (1909); 354 (1911)] have shown that at temperatures from $-127°$ to 104° C. RaEm has definite and constant values of vapour pressure corresponding to every temperature. Below $-127°$ the only knowledge concerning the volatilisation of condensed emanation is that given by the flow method of experiment originally devised by Rutherford and Soddy. In the present experiments the author has shown by a more direct static method that the vapour phase can be traced to a temperature as low as $-180°$ C. E. M.

1355. *Transformation of Actinium Emanation.* **H. Geiger.** (Phil. Mag. 22. pp. 201–204, July, 1911.)—The experiments of Geiger and Marsden have shown either that an atom of ActEm emits on disintegration two α-particles simultaneously, or that the emanation is followed by an α-ray product of period less than $\frac{1}{10}$ second [Abstract No. 79 (1911)]. The author has now shown that the latter hypothesis holds, and that ActEm is complex, consisting of two products. The first one—the emanation with a period of 4 sec.—emits α-rays of range 5·7 cm. The second product emits α-rays of range 6·5 cm., and has a period of the order $\frac{1}{500}$ sec. The range of the α-particle from ActX was also determined and found to be 4·4 cm. E. M.

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1356. *Theory of Sector-shutter Blades and Iris Diaphragms.* **C. F. Lan-Davis.** (Photographic Journ. 51. pp. 174–183; Discussion, pp. 183–185, April, 1911.)

1357. *Colour of Silver Particles in Colloidal Solutions.* **E. Müller.** (Ann. d. Physik, 35. 3. pp. 500–510, July 11, 1911.)—On the suggestion of H. Siedentopf, the present author here applies to colloidal silver solutions the theory developed by G. Mie. Graphs are given showing the radiation to be expected from very small particles of perfect conductors, of silver and of gold. The optical resonance of silver and gold spherules is also dealt with and curves plotted. E. H. B.

1358. *Number of Centres of Light Emission, and the Intensity Ratio of different Orders of Interference.* **J. Stark.** (Ann. d. Physik, 35. 3. pp. 486–499, July 11, 1911.)—This paper is the third of a series [see Abstract No. 231 (1911)] and commences with a discussion of the earlier observations. A new method of observing the interference due to a grating is described, and tables showing the results obtained are given. A. E. G.

1359. *Photography: the Latent Image.* **W. D. Bancroft.** (Journ. Phys. Chem. 15. pp. 551–579, June, 1911.)—A review of the evidence as to the sub-halide, silver germ, solid solution, or molecular structure explanations of the latent image. The solid solution theory is to be more fully discussed later. [See Abstracts Nos. 891, 986 (1910); 1018 (1911).] A. D.

1360. *Structure and Optics of Large Crystal-drops.* **O. Lehmann.** (Phys. Zeitschr. 12. pp. 540–546, July 1, 1911. Ann. d. Physik, 35. 2. pp. 193–219, June 29, 1911.)—An account is given of the behaviour of liquid-crystalline drops floating freely in a liquid medium or distorted in various ways. The papers are illustrated by a large series of diagrams. T. M. L.

1361. *Paradoxes in Terrestrial Optics.* **G. Sagnac.** (Comptes Rendus, 153, pp. 243–245, July 24, 1911.)—Sets forth several paradoxes in optical effects of the first order owing to the earth's translation. The points raised have special reference to recent work by Giuganino [see Abstract No. 1332 (1911)]. E. H. B

1362. *Band Spectrum of Lead.* **H. Lamprecht.** (Zeitschr. wiss. Phot. 10. pp. 16–29 and 33–51, Aug., 1911.)—The author has carefully re-measured the lines in the band spectrum of lead, long exposures giving many new lines. These he splits up into eleven series, which are used to demonstrate the validity of Deslandres' laws. Tables and diagrams are given, the last table giving the Deslandres' constants for each series. A. W.

1363. *Spectrum of Silver.* **F. J. Kasper.** (Zeitschr. wiss. Phot. 10. pp. 53–61, Aug., 1911.)—Gives tables of the arc and spark spectra of silver determined with greater accuracy than heretofore. The lines measured by Kayser and Runge were not sharp, whereas those obtained by the author, using powdered silver in carbon electrodes, were very sharp and could consequently be measured with great accuracy. A. W.

1364. *Long-wave Portion of Copper Spark and Arc Spectra.* **M. Aretz.** (Zeitschr. wiss. Phot. 9. pp. 256–269, April, 1911.)—Gives tables, including many new lines, of the spark spectrum of copper from λ4702·921 to λ5782·131, and of the arc spectrum from λ5034·325 to λ6920·287, also of the air lines from λ4705·426 to λ6610·421. A. W.

1365. *Infra-red Spectra.* **H. M. Randall.** (Astrophys. Journ. 34. pp. 1–20, July, 1911.)—The work described in the present paper deals with the spectra of 11 elements (Cu, Ag, Cs, Rb, Sr, Ba, Sn, Pb, As, Sb, and Bi) in the region 7500 to 30,000 Å.U. Paschen's spectrobolometer, previously described [Abstract No. 78 (1911)], was employed in the research. Important data are furnished for the establishment of series laws and especially the combination principle of Ritz. [See also Abstracts Nos. 808 (1908) and 98 (1911).] A. W.

1366. *Influence of Temperature and Magnetisation on Selective Absorption and Fluorescence Spectra.* **H. du Bois and G. J. Elias.** (Ann. d. Physik, 35. 4. pp. 617–678, July 25, 1911. From the Bosscha Laborat.)—An extension of previous work [see Abstracts Nos. 1425 (1908), 67 (1909), 46 and 1015 (1911)]; the materials dealt with belong to (1) the iron series, (2) rare earths series, and (3) uranium series. Under the second head, the behaviour of erbium nitrate is detailed in a series of tables which occupy thirty-two pages of the present paper. A number of coloured fluorescence and absorption spectra of ruby are also given. G. E. A.

HEAT.

1367. *The Tension of Expansibility.* **L. Gay.** (Comptes Rendus, 153. pp. 262–264, July 24, 1911.)—By the tension of expansibility of a fluid relative to a constituent is meant the tension which this constituent would have when it is in the gaseous condition and in osmotic equilibrium with the fluid. For homogeneous substances the law connecting pressure, volume, and temperature is determined. It contains two constants which have to be determined experimentally. The case of mixtures is also considered. A. K.

1368. *Comparison of Platinum Thermometers with the Nitrogen, Hydrogen, and Helium Thermometers, and Determination of some Fixed Points between 200° and 450°.* **L. Holborn and F. Henning.** (Ann. d. Physik, 35. 4. pp. 761–774, July 25, 1911. Communication from the Physikal.-Techn. Reichsanstalt.)—The authors have carried out a comparison of the Pt thermometer with gas thermometers using nitrogen, hydrogen, and helium in tubes of Jena glass No. 59^{III}, also nitrogen in quartz tubes, at temperatures of 200° and 450°. Helium passed to a certain small extent through the Jena glass, but the measurements could still be made use of by introducing a correction. The value of δ in the Callendar formula $t - t_p = \delta(t/100 - 1)(t/100)$ was found to be the same in the case of helium and hydrogen in Jena glass and of nitrogen in quartz, but was slightly lower in the case of nitrogen in Jena glass. In the case of the gas thermometers, the constant-volume thermometer was employed. The ideal thermodynamic scale was taken as basis, and this was effected by referring all temperatures to those of the helium or hydrogen thermometer. To fix the thermometric scale, a re-determination of the boiling-point of sulphur was made and found to be 444·51°. Using the values of δ obtained, the previous determinations of the boiling-points of naphthalin and of benzophenone were recalculated to 217·96° and 305·89° respectively. The freezing-points of Zn, Cd, and Sn were determined and found to be 419·40°, 320·92°, and 231·83° respectively. The values for the boiling-points agree very well with those of Callendar and Griffiths and of Waidner and Burgess, but in the case of the freezing-points the differences are slightly greater, probably due to impurities in the metals. A. F.

1369. *Internal Pressure of Gases, and Law of Molecular Attraction.* **A. Leduc.** (Comptes Rendus, 153. pp. 179–182, July 17, 1911.)—Calculating from formulæ already established [Abstracts Nos. 1074, 1252, 1254 (1909), and 1171 (1911)] the author shows that the internal pressure of SO_2 diminishes with rise of temperature, rendering the equations of Van der Waals, Clausius, and Sarrau incorrect. At corresponding temperatures, and for gases of the same molecular constitution, the mutual attraction between two molecules of the same gas is found to be proportional to the square of their mass and inversely proportional to the fourth power of their distance apart. W. H. Si.

REFERENCE.

1370. *Isotherms of Diatomic Gases and of their Binary Mixtures.* VIII. *Control Measurements with the Volumenometer.* **W. J. de Haas.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 101–113, June 28, 1911. Communication No. 121*a* from the Phys. Lab., Leiden.)—The author describes the calibration and control measurements with a volumenometer employed for the determination of the compressibility of hydrogen. A. F.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

1371. *Velocities of Electrons produced by Ultra-violet Light.* **A. L. Hughes.** (Cambridge Phil. Soc., Proc. 16. pp. 167–174, May 18, 1911.)—The velocities of electrons emitted by metals have been measured by Lenard, Ladenburg [Abstract No. 1061 (1907)] and Millikan and Winchester [Abstract No. 1674 (1907)]. The results obtained show considerable discrepancies, far larger than any possible error of experiment. The most probable explanation is that there is some kind of film, probably of gas, present on the surface of metals which retards the electrons. It is hardly likely that the various methods of polishing the surfaces should leave the film in exactly the same condition. The velocities obtained by Ladenburg were 1·12 volts for Zn, 1·69 volts for Cu, and 1·86 volts for Pt, using light of wave-length λ2010. v. Baeyer and Gehrts [Abstract No. 259 (1911)] tried the effect of passing a discharge through the apparatus while it was being exhausted, and found that after this treatment the max. velocity was 6·8 volts for the metals Al, Cu, and Au. With a view to finding the true velocity of emission, surfaces are now employed which have been subjected to special treatment. The variations in the velocities after different kinds of treatment are considered as evidence of changes in the supposed surface film. The experiments tried include the effect of using the metal as anode, as kathode, of allowing the metal to stand in different gases, and of preparing the metal surface by distillation *in vacuo* wherever practicable. The source of light is a mercury arc in fused quartz, the limit of transparency of which is taken as about 2000. Ni, Cu, Zn, Cd, and Hg are the metals employed. On four occasions emission velocities greater than 6·8 volts were obtained, the highest being 6·74 volts. The general decrease in velocity of emission after a big value has been obtained is suggested by v. Baeyer and Gehrts to be due to some gas, probably hydrogen, diffusing out of the metal and slowly forming a surface film. These experiments do not support this view, as the emission velocities are least affected by hydrogen. Oxygen is found to produce a marked decrease, which is, however, followed by a slight increase. This suggests that the film formed in this way is not so tenacious as the film on ordinary surfaces. [See also Abstract No. 1378 (1911).] A. E. G.

1372. *Determination of the Charge on Silver Particles.* **E. Weiss.** (Phys. Zeitschr. 12. pp. 630–633, Aug. 1, 1911.)—The method of Ehrenhaft of observing microscopically the paths of particles in the gravitational and electrical field is adopted. The chief point in these experiments is the repeated observations of the same particle. The results show the average value of the unit charge to be about $4{\cdot}5 \times 10^{-10}$ e.s. unit. Certain sources of error are pointed out which it is believed can be removed by working in an atmosphere of argon. Experiments in this direction are in progress.

A. E. G.

1373. ***Magnetic Field produced by Charged Condenser moving through Space.*** **W. F. G. Swann.** (Phil. Mag. 22. pp. 150–168, July, 1911. Paper read before the British Assoc., 1910.)—A system of charged bodies moving through space with velocity v, should, on the assumption of a quiescent ether, give rise to a magnetic field which at each point is equal to $4\pi vP$, where P is the electric polarisation at that point resolved perpendicular to the velocity v. Röntgen tried to detect this field by its effect on a magnetic needle, but no such effect was observed. J. Larmor showed that the induced charge on the needle annulled the other effect. It seems at first sight that the effect might be detected by a rotating coil. But on examination that method fails also if the space inside the coil is filled with material of constant specific inductive capacity. It is then shown that if part of the space inside the coil is filled with dielectric material of one kind (say paraffin wax) and the other left vacuous, a resultant magnetic flux should be obtained through the coil, provided that the specific inductive capacity is a quantity which may be looked upon as continuous throughout the medium to which it refers. The negative result of the experiments thus favours the belief in the presence of something of the nature of electric doublets in the dielectric. E. H. B.

1374. *Lines of Force due to given Static Charges.* **D. N. Mallik.** (Phil. Mag. 22. pp. 177–190, July, 1911.)—In Maxwell's Treatise a graphical method of drawing lines of force due to static charges is given. The author considers fully a simpler geometrical method of drawing these lines. When we have two point-charges e_1 and e_2 it is easy to prove that the lines of force are given by the equation $e_1 \cos \theta_1 + e_2 \cos \theta_2 = \text{const.}$ This equation is the foundation of the geometrical method given. The six diagrams drawn prove that it can be readily applied in practice. A. R.

DISCHARGE AND OSCILLATIONS.

1375. *Velocity of Ions of Alkali Salt Vapours in Flames.* **H. A. Wilson.** (Phil. Mag. 21. pp. 711–718, June, 1911.)—In flames all alkali metals give [Abstract No. 1722 (1899)] positive ions which have equal velocities, 70 cm./sec. in unit electric field. The product Ne has the same value in flames as in salt solutions, which makes it probable that each atom of the metal forms one monovalent positive ion. How, then, do Li and Cs give equal velocities in spite of the difference in the atomic weights? The suggestion is here made, and followed up, that the alkali metal in the flame is ionised for only a fraction of the time and that, *e.g.*, the Cs atom is ionised for a much larger fraction of the time than a Li atom. The relative values of the fraction for different salts can be deduced from the conductivities which they impart to the flame. Roughly, the fraction varies as $(\text{at. wt.})^{\frac{1}{2}}$. The evidence is not inconsistent with the view that the positive ions are single atoms of the alkali metal; and that the negative are electrons. A. D.

1376. *Mode of Ionisation by Röntgen Rays.* **W. H. Bragg.** (Phil. Mag. 22. pp. 222–223, July, 1911.)—Millikan and Fletcher [Abstract No. 1208 (1911)] state that an oil-drop caught very few negative ions when placed a few mm. to one side of a stream of Röntgen rays passing through air at atmospheric pressure; the imposed electric field being such as to urge negative ions made in the stream to move away from the drop. From this they conclude that the greater part of the ionisation of a gas by Röntgen rays is due to the direct action of the primary rays. It is now pointed out that this conclusion does not clash at all with a certain consequence [Abstract No. 1716 (1910)] of the corpuscular theory of Röntgen rays, which is, that ionisation of Röntgen rays is effected indirectly by the kathode rays which spring from the Röntgen rays, and that there is no direct ionising action of the primary rays. The kathode rays have a range in air of 2 or 3 mm. at the outside, and only the more penetrating as much as that. All but a very small fraction of the ionisation is to be found less than 1 mm. away from the primary stream of Röntgen rays. A. E. G.

1377. *Charges on Ions in Gases.* **J. S. Townsend.** (Phil. Mag. 22. pp. 204–211, July, 1911.)—This is a criticism of the conclusion of Millikan and Fletcher [Abstract No. 1208 (1911)] that no ions with double charges are produced in a gas by primary or secondary Röntgen rays. It is now stated that it is not the nature of the gas that determines whether or no large values of N*e* are obtained. The principal factor that has to be considered appears to be the kind of radiation that is used. The simplest explanation is that positive ions with single charges are produced, when the rays consist of projected particles (which compose the non-penetrating secondary Röntgen rays), and that positive ions with double charges are produced by the direct action of the more penetrating secondary rays, which resemble the Röntgen rays in not being deflected by a magnetic field. This hypothesis seems to be in accordance with most of the experiments, but as there is a good deal of uncertainty as to the way in which gases are ionised by Röntgen rays, it can only be considered as a temporary explanation. The reliability of the method adopted by Millikan and Fletcher for testing whether positive ions with double charges are present is questioned, and the evidence brought forward by them to show that all the positive ions in the gas have single atomic charges is not considered conclusive. A. E. G.

1378. *Initial Velocity of Photoelectrically liberated Electrons.* **O. v. Baeyer** and **A. Tool.** (Deutsch. Phys. Gesell., Verh. 13. 15. pp. 569–572, Aug. 15, 1911.)—O. v. Baeyer and A. Gehrts have observed initial velocities of photoelectrically liberated electrons as high as 6·8 volts. The present experiments are undertaken to ascertain whether it is possible to obtain still higher velocities. When the Pt plate on which the light falls is made the anode, a very high value is obtained for the initial velocity of the liberated electrons. This velocity decreased rapidly with the time. When a discharge lasting a fraction of a second is sent through the tube an initial velocity of 20 volts is obtained; this decreases at first quickly, then more slowly, but at the end of 20 hours it still amounts to 6 volts. When the Pt plate is made the kathode smaller initial velocities are obtained. The conclusion come to is that the high velocities are solely due to an alteration of the Volta-effects between the electrodes. A. E. G.

1379. *Theory of the Selective Photo-effect.* **F. A. Lindemann.** (Deutsch. Phys. Gesell., Verh. 13. 12. pp. 482–488, June 30, 1911.)—The selective photo-effect only occurs when the electric vector swings in the plane of incidence. The author attempts a theory of the effect based upon this fact. He supposes that electrons describe elliptical orbits about positive nuclei. If the latter has a valency n and the distance apart is r, then a simple deduction resembling Kepler's reasoning gives $2\pi c r^{3/2}/(ne^2/m)^{1/2}$ for the wave-length, c being the velocity of light, and e and m respectively the charge and mass of the electron. When the incident light vector swings with this period, the eccentricity of the ellipse becomes so great as to lead to the "photoelectric" expulsion of the electron. With a tetrahedral arrangement of atoms, r becomes $2^{1/6} \times (A/Nd)^{1/3}/2$ where A is the atomic weight, d the density, and N the number of molecules per mol. (6×10^{23}). For potassium, r becomes $2{\cdot}37 \times 10^{-8}$, whence $\lambda = 488$ $\mu\mu$. Since r^3 varies as the atomic volume a, the max. resonance may be calculated for all metals from the formula $\lambda = 65{\cdot}3\sqrt{(a/n)}$. The calculated values are Cs 550, Rb 490 (obs. 480), K 488 (obs. 440), Na 317 (obs. 320), Li 225, Ba 280 (obs. 280), Sr 271, Ca 238, and Mg 172. For other metals the maxima would lie so far in the ultra-violet as to be undiscoverable with present means. E. E. F.

1380. *Selective Photoelectric Effect in Barium.* **R. Pohl** and **P. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 13. 12. pp. 474–481, June 30, 1911.)—A selective photo-effect has been found in the liquid K-Na alloy and in the pure metals Rb, K, and Na [Abstracts Nos. 1784 (1909); 842 (1910); 508 and 778 (1911)]. A search was made for a similar effect in Ba, Hg, Pb, Tl, Sn, Cd, and Bi. Oxidation of the surface was prevented by fusing the metal in a combustion tube and pouring it into the photo cell, both operations being conducted in a vacuum. The light was given by a mercury lamp and its energy measured with a Rubens thermo-couple. All the metals enumerated show a photoelectric effect, which begins at a wave-length that is the greater the more oxidisable the metal. But it is a normal effect in all the metals, except in the case of barium, which shows a maximum at 280 $\mu\mu$. Bright surfaces of Ba were obtained by splitting the metal with a hammer in a vacuum. E. E. F.

1381. *Photoelectric Potassium Cells.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 12. pp. 609–614, Aug. 1, 1911.)—The photo-effect in alkali metals may be increased by making them the kathode in a glow discharge through low-pressure hydrogen. The metals are then coloured green or blue, except sodium which takes a brown colour. The cells so prepared show a gradual increase in the vacuum and a fading of the colour. The fading appears to be due to the formation of a colourless hydride, which also accounts for the absorption of the hydrogen. More permanent cells, suitable for photometry, may be obtained by filling them with argon or helium. The author gives detailed instructions how to do this. A glow discharge through these gases does not lead to a colouration of the alkali metals. E. E. F.

1382. *A Method of Generating very Soft Röntgen Rays in a very High Vacuum.* **H. Dember.** (Deutsch. Phys. Gesell., Verh. 13. 15. pp. 601–606, Aug. 15, 1911.)—The method adopted is to so increase the velocity of electrons set free by photoelectric action that they produce Röntgen rays when they strike a suitably placed antikathode. A diagram and description of the apparatus employed is given. The experiments described show that electrons with an energy of $8{\cdot}9 \times 10^{-10}$ erg. are still able to generate Röntgen rays. A. E. G.

1383. *A New Radiation emitted by the Electric Spark.* **W. Steubing.** (Phys. Zeitschr. 12. pp. 626–630, Aug. 1, 1911.)—This paper contains the results of experiments performed to test conclusions arrived at by R. W. Wood [Abstract No. 55 (1911)]. The experimental arrangements are described in detail, and the following conclusions are the outcome of the results obtained: The ordinary condenser Al spark as produced in the apparatus used by Wood, supplies, through the unavoidable metallic vapour, an emission which consists of light from the spark, scattered by the metal particles, and is therefore independent of the nature of the gases in which the spark is produced. This emission can be entirely removed by preventing the particles from passing through the opening in the disc by a strong gas current. Its spectrum is identical with the direct spectrum of the spark which produces the emission. A. E. G.

1384. *Presence in Point Discharge of Ions of Opposite Sign.* **J. Zeleny.** (Phys. Rev. 33. pp. 70–73, July, 1911.)—Some of C. T. R. Wilson's experiments on the actions of ions as condensation nuclei indicate that negative ions are present in the gas to which a point is discharging positive electricity, and similar results were obtained by N. R. Campbell. Chattock and Tyndall [Abstract No. 967 (1910)] have considered a back discharge from the plane to be a possible explanation for the high values they obtained, from wind pressure, for the mobility of the negative ions in point discharge in pure hydrogen. The present experiments, in which dry air and hydrogen are used at different pressures, are undertaken to find whether such ions, of a sign opposite to that of the main discharge, are present at some distance from the point in sufficient number to affect the electric field appreciably. The method adopted is based on the fact that when a wire probe placed in a gas containing ions is charged to a higher potential than that which it takes up of itself, it cannot return to the latter potential if positive ions only are present, nor can it recover from an imposed lower potential if negative ions alone are present. Any leakage through the gas from a probe wire placed near a discharging point and charged as stated, must be due to the presence of ions opposite in sign to that of the main discharge. The experiments show that the number of negative ions in the positive discharge is greater than the number of positive in the negative discharge. They also show that while at lower pressures, and especially in the larger currents, there are a considerable number of ions in the gas of opposite sign to that of the discharge, yet for pressures down to as low as 15 cm. and with currents up to 7 micro-amps. at least, these ions are not sufficiently numerous to affect the electric field appreciably. A. E. G.

1385. *Passage of Electricity across very Short Air-spaces.* **F. Rother.** (Phys. Zeitschr. 12. pp. 671–674, Aug. 15, 1911.)—The passage of electricity between two carefully polished electrodes, separated from each other by distances varying from 35 $\mu\mu$ to 560 $\mu\mu$, is investigated. The voltage is kept so low that a spark is not formed. The distances are measured on an interferometer, and the electric current by a quadrant electrometer. The experiments are conducted in air at atmospheric and at 1 mm. pressure. The curves of results given indicate that for a given current-density the voltage is practically proportional to the distance, and that the sparking potential at 35 $\mu\mu$ is nearly 1 volt. T. P. B.

1386. *Potential of Discharge in the Magnetic Field.* **A. Righi.** (R. Acad. Sci. Bologna, 8. Ser. 6. 1910–1911. N. Cimento, 2. Ser. 6. pp. 5–38, July, 1911. Abstract. Phys. Zeitschr. 12. pp. 424–439, June 1, 1911.)—Continuing his work on this subject [Abstract No. 128 (1911)], the author shows that when the distance between the electrodes is increased to 10 or 15 mm., the pressure being 0·68 mm., the discharge potential rises with increase of the magnetic field, the phenomenon being particularly marked when the discs are parallel to the magnetic field. Measurements of the discharge potential at pressures as low as 0·056 mm., and others with various forms of Al electrodes, are described, which support the author's theory that the magnetic field causes ionisation of the gas, and it is considered that "magneto-ionisation" must be recognised in conjunction with the usually accepted explanation of the action of a magnetic field. The important bearing on the theory of atomic structure, of the effect of magnetism upon electrons moving in closed orbits within the atom, is pointed out. [See also Abstract No. 646 (1911).]

W. H. Sl.

1387. *Mode of Conduction in Gases illustrated by the Behaviour of Electric Vacuum Valves.* **O. Lodge.** (Phil. Mag. 22. pp. 1–7, July, 1911.)—The following points concerning the action of vacuum valves have been arrived at as the result of experiments: (1) The current in vacuum tubes is mostly conveyed unobtrusively by positively charged carriers or atoms, which travel from anode to kathode as best they can, readily taking a roundabout path if necessary. (2) From the surface of the kathode a bombardment of negative corpuscles or electrons occurs from every place at adequate tension, and issues everywhere perpendicular to the surface without regard to destination. At high vacua these projectiles travel with prodigious speed for a considerable distance, and they have the effect of blocking the path by driving back any small bodies such as atoms advancing in an opposite direction. The negatively charged projectiles carry only an insignificant proportion of the whole current, though they may assist in propelling uncharged atoms towards the anode, where they can become positive ions. (3) Circulation of material in the tube is necessary, so as to maintain a constant supply of positively charged ions, and to enable them to act as carriers. However plentifully electrons are supplied to the kathode by the source of current, they do not spontaneously escape from the metal (except under some stimulus such as ultra-violet light provides) unless positively charged ions are in their neighbourhood. In an active vacuum tube the continual presence of such ions near the kathode depends on their having been able to travel from the anode; nevertheless they are not atoms of the anode itself, but are gas atoms which have become positively charged by contact with it. It is at the surface of the anode, therefore, that the separation of electricities really takes place under the stress of the applied e.m.f. If now a kathode is mounted so as to fire down a narrow tube along which the positive carriers must come, no current can pass. When some indirect route in which the bombardment is less vigorous is provided, whereby a stream of positive carriers can reach the kathode, a passage of current takes place. The general direction of the whole bombardment depends upon the shape and aspect of the kathode, and this question is discussed in detail. The result of this is that a vacuum valve should have one terminal situated so that it can fire down a constricted space and stop any procession coming along it, while the other terminal should be in a roomy chamber; this latter terminal should have points or edges, whence the bombardment will be diffuse. An illustrative experiment with diagram of suitable tube is given. The reason why the current is mainly carried by the positive ions is discussed, and it is pointed out that while the current in gases is mainly due to positive ions, in metals the conduction is almost certainly due to the free migration of electrons, while in liquid electrolytes the conduction is distributed between the positive and negative ions. The fact that the conveyors of electricity have to change in sign when a current passes from a metal to a gas, or *vice versa,* which exchange can only be effected by a neutralisation or combination of the opposite charges at the bounding surface, suffices to account for some of the heat which is there produced. **A. E. G.**

1388. *Progressive Diminution in Intensity of Ultra-violet Rays from Quartz-tube Mercury Lamps.* **J. Courmont** and **C. Nogier.** (Comptes Rendus, 152. pp. 1746–1747, June 19, 1911.)—Quartz-tube mercury vapour lamps, operating at a high temperature, yield a spectrum which is very rich in ultra-violet rays. The authors, however, find that the efficiency in this respect diminishes notably with time. Spectrometric investigations showed that a less intense spectrum is secured after a few months, and the chemical effect on paper soaked in potassium ferrocyanide, the destructive action on bacteria, and the influence on the skin are also less marked. This weakening seems to be due to the gradual formation of a grey deposit inside the tube, possibly mercury silicate. It may also arise through a change in the gaseous composition of the tube. Experience suggests that it is due mainly to the high temperature, and the practice of cooling lamps during their period of action might be beneficial. **J. S. D.**

1389. *Prevention of Formation of an Arc in Oscillatory Circuits.* **K. Rottgardt.** (Phys. Zeitschr. 12. pp. 652–657, Aug. 15, 1911. Communication from the Kaiserl. Telegraphen-Versuchsamt.)—An arc is formed across the gap of a condenser circuit which is excited by an alternating current, when sufficient time for the de-ionising of the gap does not elapse between the discharge and the next charging wave. The arc may therefore be changed into a spark by increasing the damping of the condenser circuit by inserting resistance. The longer the period of oscillation and the greater the energy of discharge, the greater must this resistance be. The same result may be brought about by coupling a strongly damped, tuned circuit with the first circuit. By means of this last arrangement the time which is required for the de-ionising of the spark-gap may be determined. In the experiments the metal of the spark-gap is zinc, and it is found that in this case and with alternating current at 500 cycles per sec. almost the whole disposable time is required for the de-ionising of the spark-gap. **T. P. B.**

1390. *Sparking Potential and Frequency of Oscillation.* **J. C. Hubbard.** (Phys. Rev. 32. pp. 565–580, June, 1911.)—The paper gives a study of the relation between spark-length, potential, and frequency for oscillating potentials having frequencies from 4000 to 18,000 per sec., and for spark-lengths ranging from 0·005 to 0·0005 cm. The potentials are produced by interrupting a known initial current in a circuit containing inductance with capacity in parallel. The interruption is made in such a way that no spark is produced at the break. The experiments relate to air at atmospheric pressure. It is found that the spark-lengths are linearly related to the strengths of the initial current, the inductance and capacity remaining the same, *i.e.*, the spark constants in the equation $V = ax + b$ are independent of the amplitude alone of the oscillating potential. The spark constants vary with the frequency. The constant a is, within the limits of the experiments, a rapidly increasing linear function of the frequency. At a frequency of 4000 per sec., for instance, it has nearly three times its value for steady potentials. The value of the constant b is practically the same as for steady potentials, showing, however, a tendency to increase with the frequency. It is therefore concluded that the lag effect of the electric spark depends upon some process in the gas, which takes time for its completion such that the shorter the time the greater is the necessary sparking potential. The results are in accord with J. J. Thomson's theory of the spark discharge. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1391. *Theory of the Sensitiveness of Selenium to Light.* **C. Ries.** (Phys. Zeitschr. 12. pp. 480–490, June 15, and pp. 522–538, July 1, 1911.)—Several arguments are adduced against any chemical theory of the sensitiveness of Se, such as that put forward by Berndt [Abstract No. 1513 (1904)], and elaborated by Marc. No evolution of heat can be traced in the supposed allotropic transformations, and the sensitiveness continues unabated down to —185° C., where chemical processes are usually stagnant. The author favours an electron theory of the sensitiveness, which brings it into line with other photoelectric actions. He supposes that light liberates from the atoms of Se electrons of not very great velocity. These, instead of emerging from the substance, remain within it, and add to the number of conducting electrons, thus increasing the conductivity. That light does not transform Se into a specifically lighter variety, as alleged by Kruyt, the author proved by suspending a disc of Se, 0·78 mm. thick and weighing 121 gm., in alcohol, and measuring its buoyancy. The latter was found to vary in a manner solely attributable to the absorption of heat. The so-called anomalous or negative effect in Se is not an effect of light, but is due to the passage of the current; it diminishes as the light becomes more intense. The anomalous behaviour of cells is due solely to moisture, and may be cancelled by exposing the cells to a current of dry air. Conversely, normal cells may be rendered anomalous by surrounding them with moist air. As regards inertia, it may also be attributed to the passage of the current. That ordinary metals show no photoelectric increase of conductivity, although they do show a photoelectric discharge, is due to the fact that in their case the number of free electrons is already so large that those liberated by light do not make any difference. When the metal is granular, however, like Wilson's granular silver, an increase of conductivity is produced by light, no doubt owing to discharges between the granules. Such discharges probably take place between the atoms of illuminated Se. The photoelectric power of Se is high, chiefly in the more refrangible light. That it is chiefly sensitive to red light is not surprising, since it is greatly a matter of the energy of the incident light, which is greatest at the red end. E. E. F.

1392. *Effect of a Narrow Saw-cut in the Edge of a Conducting Strip on the Potential- and Stream-lines in the Strip and on its Resistance.* **C. H. Lees.** (Phys. Soc., Proc. 23. pp. 361–366, Aug., 1911.)—By means of the Schwarzian transformation it is shown that if a fine saw-cut is made in the edge of a long conducting strip, perpendicular to the edge, the resistance of the strip is increased by an amount equivalent to that of a length of strip equal to $(4/\pi)\log_e\sec(\pi c/2)$ breadths, where c is the ratio of the depth of the cut to the breadth of the strip. Diagrams of the stream- and potential-lines near the cut are given and a table showing that the positions of points at given potentials on the edges of a strip vary with the depth of the cut. A. R.

1393. *Absolute Measurement of the Ampere.* **E. Gehrcke and M. v. Wogau.** (Deutsch. Phys. Gesell., Verh. 13. 12. pp. 470–478, June 30, 1911.

Communication from the Physikal.-Techn. Reichsanstalt.)—In taking 1 c.g.s. unit of current equal to 10 international amps., a small error is introduced, Kohlrausch having shown that 0·9998 c.g.s. = 9·998 abs. amps. = 10 int. amps. The variation between the two values is within the limits of the accuracy obtained in previous measurements [see Abstract No. 1396 (1911)] and the value of the international ampere might thus be measured in terms of the c.g.s. unit, by means of the null method of magnetic fields referred to. A coil with known constant is set up with its axis along the magnetic meridian, and a current of such strength passed through the coil as to neutralise the earth's horizontal component within the coil. H being known to 1 in 10,000, it is proposed to determine, by this method, the value of the ampere in absolute units. G. E. A.

1394. *Thermoelectric Effects and Electron Theory.* **J. Koenigsberger** and **J. Weiss.** (Ann. d. Physik, 35. 1. pp. 1–46, June 2, 1911.)—In continuation of the work of J. Weiss the present authors have examined a number of substances as to their thermoelectric e.m.f.'s, their Thomson heat-effects, and their thermal conductivities, and then test the agreement of these experimental data with the electron theory. The substances examined include silicon, molybdenite, iron disulphide, various oxides of iron, manganite, and graphite. The conclusion is reached that the theory of free electrons in solid bodies gives a picture of the phenomena which in some important respects accords with what is observed to occur. Apart from the value of the constant in the Wiedemann-Franz law and the applicability of the dissociation formula, the thermal conductivity shows a fairly good agreement with the most probable values of N (the number of electrons) and *l* (the mean free path). E. H. B.

1395. *Registering Electrometer.* **P. Villard.** (Comptes Rendus, 153. pp. 315–318, July 31, 1911.)—Describes a carbon-filament electrometer of small capacity whose sensibility can be varied at will, the scale ranging, according to what is required, from several hundred volts or only a few volts. The electrometer is composed of two small rectangular plates connected to the two poles of a dry pile, between which can oscillate freely a U-shaped carbon lamp filament held by an insulating rod of amber. The lamp filament offers considerable advantages for this kind of work; it is much lighter than metals, perfectly elastic and free from all residual or spontaneous deformation. The weight of the needle and its moment of inertia are consequently very small and the zero is absolutely stable. The U-shape suppresses the displacements other than those perpendicular to the plane containing the two branches of the filament. The filaments which have been found best are those from 5- or 10-c.p. 110-volt lamps. The latter give a very high sensibility, which can be much further increased by reducing the filament in a flame. The best results are obtained when this reducing is progressive, increasing from the base to the free extremity of the filament. A filament thus treated is sufficiently flexible to detect a hundredth of a volt, and the resistance of the air damps it completely. With stronger filaments a small piece of Al-foil is attached to the free end of the U to damp the motion. The displacements of the free extremity of the filament do not usually exceed 2 mm. to right or left of the zero. Magnification and projection on a sensitive surface are secured as follows: The mobile extremity of the filament carries, attached by a trace of wax, a very small cylindrical mirror consisting of a thin glass capillary tube silvered on the inside, the mirror being about

1 mm. long and 0·1 to 0·2 mm. diam. A 2-volt lamp furnished with a condenser lights up this mirror, and with the aid of a microscope objective and one or two divergent lenses a fine line is projected on to the sensitive paper of the registering cylinder. If the instrument is used in a firm position the filament can be fine enough to give a displacement of 4 to 5 mm. per volt, the two plates being a few mm. apart and kept at a p.d. of 100 to 120 volts. By taking a very short filament and separating the plates considerably the instrument can be modified to read up to 1000 or 2000 volts. A. W.

ALTERNATING CURRENTS AND MAGNETISM.

1396. *Magnetic Measurements.* II. **E. Gehrcke** and **M. v. Wogau.** (Deutsch. Phys. Gesell., Verh. 13. 12. pp. 448–469, June 30, 1911. Communication from the Physikal.-Techn. Reichsanstalt.)—It was calculated how to obtain the best effect, *i.e.*, greatest galvanometer throw, for circular cylinder induction coils made from a single wire with an insulating layer of vanishing thickness. Curves are drawn from which can be found the best thickness of wire to use in making a coil with given length, and outer and inner diam. The next part of the paper deals with the perfection of apparatus in order to make accurate field measurements. The field inside several solenoidal coils was explored along the axis, and curves drawn show that there is an irregular variation from the value at the centre amounting to, in general, less than 1 per cent. of that value. Part of a solenoid, in which the actual field corresponded most nearly with the theoretical value, was employed in standardising a Helmholtz rectangle, and the field strength per ampere in the homogeneous region of this coil was determined very accurately, the figures for two determinations agreeing to four places. [See also Abstract No. 274 (1910).] G. E. A.

1397. *Hysteresis Loss of Heusler Alloys.* **D. Steiner.** (Ann. d. Physik, 35. 4. pp. 727–754, July 25, 1911.)—Experiments were conducted on the hysteresis and eddy-current losses in Heusler alloys in alternating fields with periods of 2000 to 5000 per sec. The hysteresis loss increases as in iron with increasing frequency, at first quickly, then slower; and after a definite frequency is passed it diminishes. The eddy currents diminish as the frequency increases, although the change is less marked than in iron. The diminution is to be ascribed to the fact that with higher frequency the lines of force fill always a smaller cross-section of the bar. The hysteresis curves were photographically registered by a specially designed kathode-ray tube, and their areas were thereafter measured by planimeter. The max. area was found with a frequency of 4300. The Heusler alloys also behave similarly to iron in high-frequency alternating circuits, only the max. induction and the hysteresis are less. With diminishing Mn-content the area of the hysteresis curves increases. A. D. R.

RADIOLOGY AND ELECTROPHYSIOLOGY.

1398. *Anti-kathodes of Röntgen-ray Tubes.* **J. Schofield.** (Nature, 87. p. 215, Aug. 17, 1911.)—It is suggested that carborundum is so exceedingly refractory and such a very bad conductor that it might be suitable for facing antikathodes of Röntgen-ray tubes. Experiments conducted with tubes having such antikathodes and driven by a coil of low power seem to show that those tubes do not pass so readily into the hard condition. Comparative tests of a quantitative nature are required. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1399. *Specific Gravities of the Elements and the Periodic System.* **A. J. Hopkins.** (Amer. Chem. Soc., Journ. 33. pp. 1005–1027, July, 1911.)—The periodicity of the atomic volumes of the elements is shown to depend on the periodicity of their specific gravities, and symmetry in physical calculations is often better obtained by substituting specific gravities or valencies for atomic weights. A slightly modified arrangement of the periodic system is proposed, including two short complete periods of 7 elements each and 5 long, incomplete periods of 15 elements each, which is in harmony with the specific gravities, and also with the atomic volumes curve of Meyer.
W. H. Si.

1400. *Action of Radium Emanation on Thorium Salts.* **Herschfinkel.** (Comptes Rendus, 153. pp. 255–257, July 24, 1911. Chem. News, 104. p. 168, Oct. 6, 1911.)—Ramsay and Usher concluded from their experiments that RaEm causes thorium nitrate to give off CO_2 [Abstracts Nos. 1628, 2129 (1909)]. The author has repeated their experiments and come to the conclusion that the CO_2 was produced by impurities in the thorium nitrate, probably traces of oxalic acid. In the present experiments with specially purified thorium nitrate, potassium permanganate caused it to give off even more CO_2 than RaEm did. **W. Ramsay.** (Ibid. pp. 373–374, Aug. 7, 1911.)—Ramsay replies to Herschfinkel. From further experiments he upholds his view that CO_2 is produced by RaEm from pure thorium nitrate [Abstract No. 1628 (1909)]. No CO_2 could be obtained from the nitrates of Bi, Hg, or Ag. It is also pointed out that potassium permanganate, which was used by Herschfinkel, generally gives a small quantity of CO_2 on heating.
E. M.

1401. *Metallography of Selenium-Antimony System.* **H. Pelabon.** (Comptes Rendus, 153. pp. 343–346, July 31, 1911.)—Microscopic examination of alloys formed by heating together Se and Sb in various proportions indicates the formation of only one compound, Sb_2S_3, thus confirming previous electrical and thermal investigations of the system. Other selenides of antimony may be obtained from Sb_2S_3 by reduction with hydrogen.
W. H. Si.

1402. *On the Melting of Carbon.* **O. P. Watts** and **C. E. Mendenhall** (Ann. d. Physik, 35. 4. pp. 788–789, July 25, 1911. From the English. Phys Rev. 33. pp. 65–69, July, 1911.)—By showing that a rod of carbon or graphite acquires a real or definite curvature when heated to a high temperature, and by noting that certain surface changes result from this heating, La Rosa has endeavoured to prove that carbon possesses a *real* melting-point at ordinary pressures [Abstract No. 2156 (1909)]. The present authors, however, have come to the conclusion that the curvature which takes place in the rod is quite easily explainable by an increased plasticity of the material at high temperatures. If this were so it would be evident that the order of increasing curvature would be that of decreasing purity; the carbon rod which showed the greatest bending would contain the largest proportion of binding material. The experiments were carried out upon rods of 6 mm. diam. and 15–80 cm. length. Three kinds of carbon were employed: (1) Ordinary commercial carbon (from the National Carbon Co., Cleveland); (2) a very fine-grained, high-grade German carbon (Conradty), probably very similar to that employed by La Rosa; and (3) the purest graphite produced by the Acheson Graphite Co. These rods were heated by means of current from a dynamo giving 600 amps. at 110 volts. Since it was possible by this means to raise the temperature quite slowly, there was plenty of time to effect the actual temperature measurements by means of an optical pyrometer of the Holborn-Kurlbaum type, the necessary correction from the so-called "black" temperature to the real temperature of the carbon being made. The results may be summarised as follows: (1) A permanent curvature is taken most easily by American carbon. Intermediate results are obtained with rods of German carbon, which are, of course, of nearly pure materials; whilst the greatest difficulty of all is experienced when pure graphite is being experimented upon. This succession represents the order of increasing impurity, that is, of decreasing carbon-content in the rods. The curving then evidently proceeds from the traces of binding materials (hydrocarbons) left in the carbons, the low results obtainable with graphite being attributable to the long and intense heating to which the material has been subjected during manufacture. Nevertheless, the authors succeeded in obtaining with graphite curvatures as well marked as any observed by La Rosa. Thus a sharp bend of 50 degrees was observed in a graphite rod after 4 minutes' heating at a temperature between 2700° and 2800° C. It was observed that a rod which has already been bent by heating may be given a much larger curvature by allowing it to cool under tension. This phenomenon was noted especially in the case of graphite. Finally, in order to produce some of the remaining phenomena described by La Rosa, who claimed to have obtained fragments of carbon with rounded edges and surface of very fine spherical structure, phenomena which La Rosa has ascribed to melting, arrangements were made by which (1) the rods or tubes could be heated slowly and quite regularly, and (2) quickly. In the first case the ends of the rods or tubes after fracture never showed any signs of melting, except that they were sometimes partly covered with a skin or a crust whose structure was formed by microscopic drops like La Rosa has described. Unfortunately it was generally upon the colder parts of the heated tube that this additional graphite, harder and finer-grained than the original graphite, was deposited. In the second case (quick heating) violent explosions, apparently proceeding from the quick production of carbon vapour, would frequently be obtained. At any rate, the marked swelling of the rod, or the tubercular-like surface, caused by the streaming of vapour from the centre of the rod, produced phenomena which are evidently the same as were observed by La Rosa and brought forward by him as "evidence of melting." C. A. W.

1408. *Extraction of Gas from Copper heated in a Vacuum.* **M. Guichard.** (Comptes Rendus, 153. pp. 104–107, July 10, 1911.)—During the first few hours considerable quantities of gas are evolved when various samples of copper are heated in a vacuum, but in time the rate of evolution becomes constant though very slow. A sample of copper wire gave off 6·56 c.cm. in the first 7 hours at 600° C., but during the next 7 hours the rate of evolution was only 0·009 c.cm. per hour. After completely cooling more gas can be obtained on re-heating. Apparently the gas is evolved from the surface of the copper, to which it diffuses only slowly. The gas is not eliminated rapidly above the melting-point of copper, since the solubility appears to increase with the temperature. The gas appears to consist mainly of CO_2, hydrogen, and nitrogen. F. C. A. H. L.

1404. *Extraction of the Gases from Copper by Chemical Reaction and the Determination of Oxygen.* **M. Guichard.** (Comptes Rendus, 153. pp. 272–275, July 24, 1911.)—The elimination of gas from copper by simple heating *in vacuo* is a very difficult matter [see preceding Abstract], and the author has therefore made determinations of the total amount of dissolved gas by converting the copper into iodide and oxide in a closed apparatus. The experiments show that industrial copper contains dissolved gases in quantities sufficient to introduce an error of several thousandths in the determination of oxygen. By using the copper in the form of wire of at most $\frac{1}{10}$ mm. diam., previously heated to 600° C. *in vacuo*, the error may be reduced to a few ten-thousandths. F. C. A. H. L.

1405. *Chrome Steels.* **Portevin.** (Comptes Rendus, 153. pp. 64–66, July 3, 1911.)—Under normal conditions of cooling, steels containing 0·1 per cent. carbon and 7 to 22 per cent. Cr are martensitic. On annealing and cooling very slowly from 1300° C. microscopic examination shows that the samples have a granular structure similar to that of ferrite. The hardness is similar to that of semi-hard ordinary steel. After annealing the samples again at 1100° C. under industrial conditions the martensitic structure is regenerated, but is accompanied by traces of troostite. At the same time the hardness is considerably increased. F. C. A. H. L.

1406. *Solubility of Carbon in Iron.* **O. Ruff** and **O. Goecke.** (Metallurgie, 8. pp. 417–421, July 22, 1911.)—Samples of iron having the percentage composition C 4·18, Mn 0·15, Si 0·074, P 0·02, S 0·006, and Cu 0·005, were melted in a graphite crucible suspended in an electrically-heated vacuum furnace in such a manner that it could at any given moment be caused to fall into a vessel of ice-cold water. Subsequently, determinations were made of the total carbon and graphite in specimens which had been heated at temperatures between 1220° and 2626° C., the elevated temperatures having been observed with Wanner pyrometers. The solubility-temperature curve shows a maximum at 2220° C. lying at a concentration corresponding to the compound Fe_3C, and a discontinuity at 1837° C. at a concentration corresponding to the compound Fe_3C. This unexpected peculiarity will be discussed in a future communication. Six photomicrographs accompany the paper. F. C. A. H. L.

1407. *Modifications of Nickel Steels by prolonged Heating and under the Action of Time.* **C. E. Guillaume.** (Comptes Rendus, 153. pp. 156–160, July 17, 1911.)—Former researches have shown that nickel steels undergo changes of volume in the course of time. Between 28 and 42 per cent. nickel the changes are positive; above this and up to 70 per cent. the changes are negative, after which they are inappreciable. Measurements taken over periods of about 12½ years on forged bars of invar (35 per cent. Ni) show that heating to 150° C. followed by slow cooling to 40° C. accelerates the transformation and reduces the magnitude of the subsequent changes as compared with those observed in bars simply exposed to ordinary temperatures (20° C.). Similar results are obtained with quenched and drawn materials. This emphasises the necessity of stoving the alloys used in instruments of precision; of being able to find by extrapolation the value of an invar standard kept between certain limits of temperature for several years; and of re-determining the value of standards which have been subjected to the prolonged action of abnormal temperatures. A table is given showing the increase of length of alloys containing from 35 to 48 per cent. Ni after various thermal and mechanical treatments and after soaking at various temperatures. F. C. A. H. L.

1408. *Annealing Rolled and Forged Carbon Steel.* (Mech. Eng. 28. pp. 282–288, Aug. 25, 1911. Abstract of report read before the Amer. Soc. for Testing Materials.)—The usual purpose in annealing steel objects is to remove coarseness of grain, and in special cases the object is to remove the effects of internal stress caused by rolling or working the metal at a low temperature. In the case of large objects, although the early stages of the heating may, if desired, be rapid, the final approach to the annealing temperature should be slow, so that the interior may be brought up to it without carrying the exterior far beyond it. The temperature should be kept long enough at the annealing point to ensure the whole of the interior reaching it. An exposure of 1 hour should be long enough for pieces 12 in. thick. For all important work the use of a pyrometer is desirable for controlling the temperature, but when the eye is relied upon the light surrounding the furnace should be dull and constant, direct sunlight being especially avoided. The annealing temperature for steels containing between 0·5 and 0·9 per cent. carbon is that at which the metal suddenly ceases to be magnetic, and this fact may sometimes be made use of for fixing or verifying the annealing temperature. In general, the higher the carbon-content the lower should be the annealing temperature. The following ranges of temperature should be used for the several ranges of carbon-content indicated. The upper limit of the temperature range applies to larger objects and to the lower part of the carbon range given. These temperatures refer to the usual moderate Mn-content; for steel with more than 0·75 per cent. Mn slightly lower temperatures suffice.

Range of Carbon-content.	Range of Annealing Temperature.
Less than 0·12 per cent.	875–925° C.
0·12 to 0·29 per cent.	840–870
0·30 to 0·49 ,,	815–840
0·50 to 1·00 ,,	790–815

Care must be taken that all parts of the object reach the same temperature, and it may be necessary to mask from the heat the thinner parts of objects of varying thickness. The cooling should be carried out in a manner which will give the desired properties and which is appropriate to the carbon-content. The higher the carbon the slower should be the cooling, and the slower the cooling the softer and more ductile will the metal be, and the lower will be its tensile strength, elastic limit, and yield-point. To give the greatest softness and ductility, even at a sacrifice of strength and elastic limit, the metal should be cooled either in the furnace or under a cover of lime, clay, &c. To give great tensile strength and high elastic limit at a certain sacrifice of ductility the cooling should be more rapid. Thick objects with less than 0·5 per cent. carbon may be cooled completely in air. Objects with 0·5 per cent. carbon or more, and thin objects with 0·3–0·5 per cent. carbon may be cooled in air if the cooling be somewhat retarded as, for instance, by massing them together, as happens in the case of rails. To give an unusually high combination of ductility with tensile strength and elastic limit the objects are quenched from the annealing temperature in oil which is kept in circulation. Water quenching may be used in the case of simple shapes and low carbon. The hardened material is then annealed as before. The duration of the second annealing must be sufficiently long to relieve the stress caused by the quenching. For pieces of moderate thickness a 4-hour exposure should suffice. To give a moderate increase of strength and elastic limit without the full sacrifice of ductility which a simple air-cooling would cause, the objects are rapidly cooled from the correct annealing temperature to a dull red heat, 650°, and thenceforth slowly. To remove the effects of rolling or otherwise working the object at an unduly low temperature it is heated to 775° and cooled with a slowness which should increase with the thickness. Such annealing for steel containing less than 0·15 per cent. carbon should be at 900°; great brittleness may be caused by annealing very low carbon steel in the neighbourhood of 700° after cold working.

C. O. B.

1409. *Conductivity accompanying Chemical Reactions.* **G. Reboul.** (Comptes Rendus, 152. pp. 1660–1661, June 12, 1911.)—The ionisation effects produced in most chemical reactions so far investigated have been shown to be due either to the rupture of the surface of the reacting liquid or to elevation of temperature [Abstracts Nos. 1631, 1632 (1909)]. In the present experiments the ionisation produced when diluted chlorine is allowed to attack various metals has been investigated. Na and K gave the largest effects, but generally the ionisation currents corresponded to a number of elementary electric charges small in comparison with the number of molecules entering into the reactions.

E. M.

1410. *Conductivity and Viscosity of Aqueous Solutions of Aniline Hydrochloride at 25°.* **N. V. Sidgwick** and **B. H. Wilsdon.** (Chem. Soc., Journ. 99. pp. 1118–1122, June, 1911.)—The molecular conductivity of aniline hydrochloride in presence of N/22-aniline was found to approach toward the value $\mu_\infty = 112{\cdot}70$. On combining with the viscosity figures it was found that the product $\mu\eta$ fell to a minimum with increasing concentration and then increased again; but the product $\mu\eta^{\frac{1}{2}}$ decreases steadily. As it is probable that the coefficient of ionisation a decreases steadily it is considered probable that $a = \mu\eta/\mu_\infty$ is probably a less correct equation than $a = \mu\eta^{\frac{1}{2}}/\mu_\infty$ for use in applying a viscosity-correction to the equivalent-conductivity.

T. M. L.

1411. *Action of Salt Solutions and of Sea Water on Iron at Various Temperatures.* **J. A. N. Friend** and **J. H. Brown.** (Chem. Soc., Journ. 99. pp. 1302–1306, June, 1911.)—Electrolytes may be divided into two classes according as their concentrated aqueous solutions prevent or retard the corrosion of iron. Most electrolytes belong to the second group, and the retarding influence may be due to the diminished solubility of oxygen in concentrated solutions. Experiments made by the authors on pure iron foil immersed in solutions of sulphates and chlorides of the alkali metals have shown that above 18° C. salt solutions of all concentrations exert a less corrosive action than pure water; below 18° C. dilute solutions are more corrosive than sea water, while at 18° C. the salt solutions are about as corrosive as distilled water. It is proposed to call this temperature the "Inversion Temperature." Similar results were obtained with sea water.

F. C. A. H. L.

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1412. *Effect of Slight Movement of a Metal in contact with an Electrolyte.* **J. Pionchon.** (Comptes Rendus, 153. pp. 47–49, July 3, 1911.)—The author has measured the effect on the e.m.f. of a cell when one of the electrodes is caused to vibrate slightly. With two Zn electrodes immersed in a $ZnSO_4$ or $ZnCl_2$ solution, or two Cu electrodes in $CuSO_4$ solution, the electrode which is made to vibrate becomes positive, the e.m.f. produced in the case of Zn electrodes in $ZnSO_4$ solution being 0·025 volt, and with Cu electrodes in $CuSO_4$ solution, 0·005 volt. With Cu electrodes in $CuCl_2$ solution the opposite effect takes place, the vibrating electrode becoming negative. In the case of a Daniell cell, the e.m.f. increases or diminishes according as the Cu or Zn electrode is agitated, an increase of 0·0046 and a decrease of 0·0190 volt being observed. W. H. Si.

1413. *Rapid Determination of Silver and Cadmium by means of the Gauze Kathode and the Stationary Anode.* **R. C. Benner** and **W. H. Ross.** (Amer. Chem. Soc., Journ. 33. pp. 1106–1112, July, 1911.)—The electrodes used were the same as those already described in the authors' paper on Ni and Co [see Abstracts Nos. 180 and 560 (1911)]. The only electrolyte which gave satisfactory results for silver was the cyanide one, the deposits being white in colour and perfectly adherent. Potassium hydroxide (up to 2 gm. in 50 c.cm. was added to prevent the solution becoming red as the electrolysis proceeded. 0·15–0·36 gm. of Ag could be deposited in 20–35 min. from an electrolyte containing 6–8 gm. of potassium cyanide in 50 c.cm., using 3 amps. Not more than 0·3 gm. of Ag should be deposited on the smaller kathodes, otherwise there is a tendency for the deposit to become spongy. The cyanide electrolyte was found to be the only satisfactory one in the case of Cd, also 0·18–0·36 gm. of Cd, were deposited quantitatively in 30–70 min. from 60–75 c.cm. of electrolyte containing 5 gm. of potassium cyanide and 1–2 gm. of potassium hydroxide, using 3–5 amps. Equally good results were obtained when enough potassium cyanide was added to dissolve the precipitate first formed, and then potassium hydroxide till the solution was alkaline. Varying the concentration of the cyanide has much less effect on the character of the deposit than in the case of silver. T. S. P.

REFERENCES.

1414. *Method of Investigating the Quantity of Radium in Rocks and Minerals.* **J. Joly.** (Phil. Mag. 22. pp. 134–150, July, 1911.)

1415. *Electrical Conductivity in Mixtures of Metals and their Salts.* II. and III. **A. H. W. Aten.** (Zeitschr. Phys. Chem. 73. 5. pp. 578–597, and pp. 624–637, 1910.)—These two communications deal with the conductivity of fused mixtures of Cd and cadmium chloride, and with the influence of different factors on the validity of Faraday's law for the electrolysis of the mixture. [See Abstract No. 863 (1910).] L. H. W.

1416. *Constitution of Water.* **J. Duclaux.** (Comptes Rendus, 152. pp. 1387–1390, May 22, 1911.)—By a variety of methods the author concludes that the "ice-molecule" dissolved in water is more complex than has generally been supposed, and attributes to it a formula $[H_2O]_6$ to $[H_2O]_{24}$. T. M. L.

1417. *Differences of Potential between Cadmium and Alcoholic Solutions of some of its Salts.* **F. H. Getman.** (Amer. Chem. Journ. 46. pp. 117–130, Aug., 1911.)—Measurements are given of the e.m.f. between cadmium and solutions of cadmium iodide in water, methyl and ethyl alcohols and cadmium chloride in water. T. M. L.